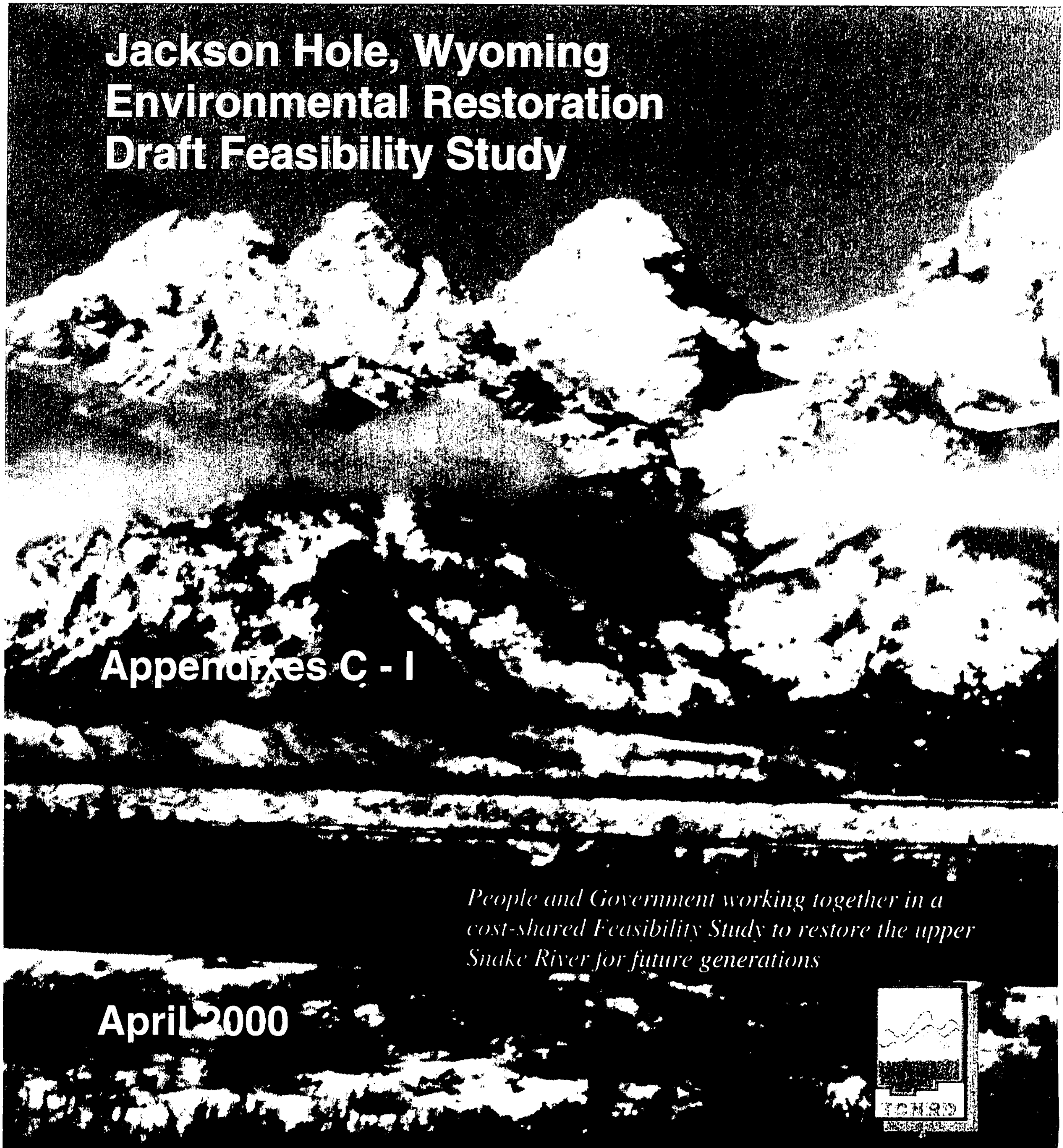
US Army Corps
of Engineers ®
Walla Walla District

Jackson Hole, Wyoming Environmental Restoration Draft Feasibility Study



Appendixes C - I

People and Government working together in a cost-shared Feasibility Study to restore the upper Snake River for future generations

April 2000

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13. ABSTRACT *(Maximum 200 words)*

The *Jackson Hole, Wyoming, Environmental Restoration Feasibility Report Draft April 2000* is the draft product of a 4-year, cost sharing feasibility study conducted by the U.S. Army Corps of Engineers, Walla Walla District, in partnership with Teton County, Wyoming, and Teton Conservation District, Wyoming. The report recommends an environmental restoration project on a 22-mile reach of the upper Snake River from Grand Teton National Park to South Park Elk Feedgrounds. The goal of the recommended project is to restore diverse and sustainable aquatic, wetland, riverside, and terrestrial habitats within the study area.

If you would like additional of the final version of the report copies (free of charge until no longer available), please contact, Mr. Stan Heller, Project Manager, U.S. Army Corps of Engineers, 201 North Third Avenue, Walla Walla, Washington 99362 (or send e-mail to: Stanley.G.Heller@nww01.usace.army.mil or telephone at 509-527-7258). The EA (Appendix H) of the report is also available at website: http://www.nwwusace.army.mil/reports/jackson.

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APPENDIX C

GROUND WATER

OF THE

JACKSON HOLE, WYOMING, ENVIRONMENTAL RESTORATION
FEASIBILITY STUDY

Prepared by

Teton County

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PART I. PURPOSE AND SCOPE

The purpose of this appendix is to provide technical support in the area of ground water elevations within the study area that could be affected by restoration measures. The Monitoring System targets the area down gradient of Study Sites 10, 9, 4, and 1 on the Westbank of the Snake River.

PART II. HISTORY AND PREVIOUS DATA COLLECTION

In the early 1990's concerns were raised by residence in the Westbank area. At that time, there was basically no documentation of ground water elevations in the area. The Wyoming State Engineer's Office and the Teton County Commission initiated the Observation Well System north off Highway 22 and west of the Snake River channel which included thirty (30) wells. Additionally, the Teton County Resource District through a co-op arrangement with the USGS installed a surface water gauging system. The Wyoming State Engineer's Office Surface Water Division installed a more expanded gauging system that monitored additional stream sites as well an irrigation diversions.

In 1997, the Wyoming State Engineer's Office Ground Water Division in co-operation with the Teton County Commission installed an additional twelve (12) observation wells south of Hwy. 22 and west of the Snake River channel. This completed the system as it exist today with the exception of the eight (8) reference wells located along the east bank of the Snake River channel, bringing the total number of wells to fifty (50).

Part III. AQUIFER BEARING MATERIAL SURVEY

Depth of the base of the Jackson aquifer, based on geophysical exploration, southern Jackson Hole, Wyoming, USA

Bernard T. Nolan · David L. Campbell
Robert M. Senterfit

Abstract A geophysical survey was conducted to determine the depth of the base of the water-table aquifer in the southern part of Jackson Hole, Wyoming, USA. Audio-magnetotellurics (AMT) measurements at 77 sites in the study area yielded electrical-resistivity logs of the subsurface, and these were used to infer lithologic changes with depth. A 100–600 ohm-m geoelectric layer, designated the Jackson aquifer, was used to represent surficial saturated, unconsolidated deposits of Quaternary age. The median depth of the base of the Jackson aquifer is estimated to be 200 ft (61 m), based on 62 sites that had sufficient resistivity data. AMT-measured values were kriged to predict the depth to the base of the aquifer throughout the southern part of Jackson Hole. Contour maps of the kriging predictions indicate that the depth of the base of the Jackson aquifer is shallow in the central part of the study area near the East and West Gros Ventre Buttes, deeper in the west near the Teton fault system, and shallow at the southern edge of Jackson Hole. Predicted, contoured depths range from 100 ft (30 m) in the south, near the confluences of Spring Creek and Flat Creek with the Snake River, to 700 ft (210 m) in the west, near the town of Wilson, Wyoming.

Résumé Une campagne géophysique a été entreprise pour préciser la profondeur du mur de l'aquifère dans le secteur sud de Jackson Hole (Wyoming, États-Unis). Des mesures audio-magnétotelluriques (audio MT) sur 77 sites de ce secteur ont fourni des logs de résistivité électrique du sous-sol : les variations de la lithologie en fonction de la profondeur en ont été déduites. Un niveau géoélectrique à 100–600 ohm.m, dénommé "aquifère de Jackson", a servi à définir des dépôts superficiels quaternaires saturés en eau et non consolidés. La profondeur médiane de la base de l'aquifère de Jackson est de l'ordre de 61 m, à partir des 62 sites ayant fourni suffisamment de données de résistivité. Les valeurs audio MT mesurées ont été krigées afin d'estimer la profondeur de la base de la formation aquifère dans la partie sud de Jackson Hole. Les cartes d'isovaleurs d'estimation krigées indiquent que la profondeur de la base de la formation aquifère de Jackson est faible dans la partie centrale de la zone d'étude à l'est et à l'ouest des monts Gros Ventre, plus grande dans le secteur ouest près de la zone faillée de Teton, et faible sur la bordure sud de Jackson Hole. Les profondeurs estimées vont de 30 m au sud, près des confluences des rivières Spring et Flat avec la rivière Snake, à 210 m à l'ouest près de la ville de Wilson (Wyoming).

Resumen Se llevó a cabo una campaña geofísica para determinar la profundidad del basamento de un acuífero libre en la zona sur de Jackson Hole, Wyoming, EEUU. USA. Medidas audio-magnetotelúricas (ATM) en 77 lugares de la zona de estudio dieron lugar a registros de resistividad eléctrica del subsuelo, que se usaron para inferir los cambios litológicos con la profundidad. Los depósitos superficiales, saturados y no consolidados de edad cuaternaria, el acuífero de Jackson, forman una capa de resistencia geoeléctrica entre 100–600 ohm-m. La profundidad media de la base del acuífero de Jackson se estima en unos 61 m (200 pies), a partir de 62 registros con medidas suficientes. Los valores ATM fueron krigeados para obtener una medida de la profundidad del basamento del acuífero en la zona sur de Jackson Hole. Los mapas de isoprofundidades obtenidos por krigeado indican que el acuífero es poco profundo en la parte central de la zona de estudio, cerca de los Gros Ventre Buttes orientales y occidentales, más profundo al oeste, cerca del sistema de fallas de Teton, y menos profundo en el borde sur de Jackson Hole. Las profundidades van desde 30 m (100 pies) en el sur, en la confluencia entre los desfiladeros Spring y Flat con el Río Snake, hasta 210 m (700 pies) al oeste, cerca de la ciudad de Wilson, Wyoming.

Key words geophysical methods · groundwater exploration · geostatistics · unconsolidated sediments

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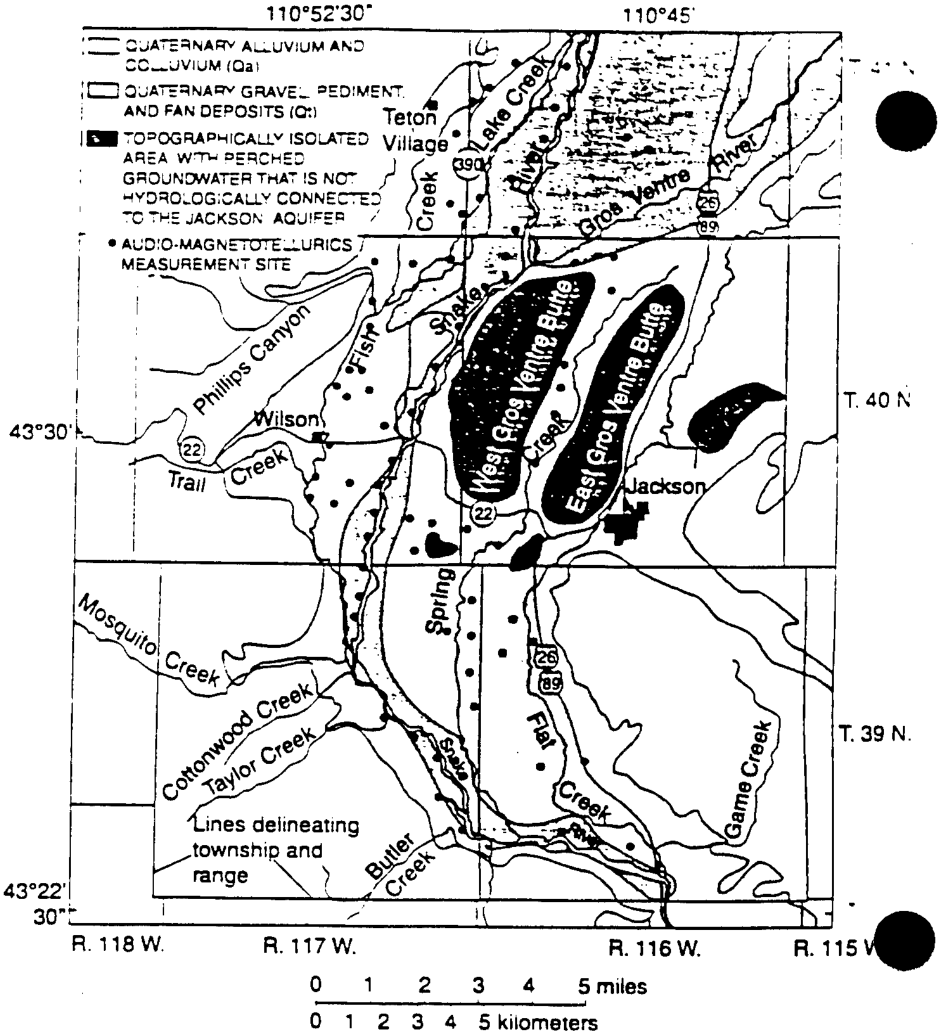

Fig. 2 Audio-magnetotellurics measurement sites in relation to Quaternary unconsolidated deposits composing Jackson aquifer. (Geology after Love and Christiansen 1985)

Electromagnetic methods measure subsurface electrical-resistivity variations as a function of frequency. Low-frequency signals penetrate farther into the subsurface and yield information on greater depths, whereas high-frequency signals pertain to shallower depths. Because electrical resistivity varies with rock type and water content, the methods can be used to infer lithology and aquifer properties.

The effectiveness of electromagnetic methods has been demonstrated in prior water-resources investigations (Zohdy 1974). Electromagnetic methods commonly are used to determine the depths to thick geologic units where electrical resistivity changes significantly. Peterson et al. (1989) demonstrate that saturated, coarse-grained unconsolidated deposits identified with time-domain electromagnetics (TDEM) have higher resistivity than adjacent units consisting of clay.

A TDEM survey conducted mostly in nearby Grand Teton National Park (Nolan and Miller 1995) indicates the presence of a significant resistivity contrast at depth. Quaternary unconsolidated deposits have high resistivities (typically 50 ohm-m or greater) and range in thickness from about 380 ft (120 m) to about 2400 ft (730 m). In contrast, deeper layers have resistivities as low as 2 ohm-m and range in thickness from about 520 ft (160 m) to about 800 ft (240 m). High resistivities indicate coarse-grained materials, such as sand, gravel, and other unconsolidated deposits, whereas low resistivities indicate fine-grained materials, such as clay, silt, claystone, shale, siltstone, or fine-grained sandstone. The contrast between high and low TDEM-indicated resistivity was used to represent the depth to the base of the full section of Quaternary unconsolidated deposits. This differs somewhat from the AMT exploration objective of the current paper – to determine the thickness of surficial saturated, Quaternary unconsolidated deposits, called the Jackson aquifer. The Jackson aquifer represents that portion of the saturated Quaternary, unconsolidated deposits that readily yields high-quality water to wells and springs. In this paper, "unconsolidated" refers to loosely aggregated materials comprising sand, gravel, silt, clay, and boulders.

AMT was used in the current study because, compared with TDEM, the method is less sensitive to cultural noise, the equipment is relatively easy to deploy, and smaller areas are required for a measurement. Implementation of AMT is more feasible than TDEM in the southern part of Jackson Hole, where numerous fences and buried cables exist. AMT equipment used by the US Geological Survey (USGS) measures natu-

the Jackson aquifer throughout the southern part of Jackson Hole.

Results and Discussion

Geologic Interpretation of Audio-Magnetotellurics Results

A total of 77 AMT measurements was made in the study area in May 1994. Subsurface lithologies and the generalized electrical-resistivity ranges used to represent them, based on visual inspection of the Bostick-inversion results, are summarized in *Table 1*. The guidelines in *Table 1* are consistent with lithologic information from available well-drillers' logs and with generalized resistivity values reported in the literature. Resistivities less than 100 ohm-m represent less permeable, saturated deposits comprising fine-grained materials, such as silt and clay; sedimentary rocks, such as claystone, siltstone, shale, and sandstone; and low-resistivity formations, such as marine shale. The less permeable, saturated deposits were assumed to have significantly smaller water yields and to contain water of lesser quality than the Jackson aquifer. In general, the lower the resistivity, the less likely that the material is an aquifer, and the more likely that it is a fine-grained confining unit.

Resistivities of 100–600 ohm-m represent the Jackson aquifer, comprising coarse-grained sediments (e.g., sand and gravel) saturated with water suitable for drinking. Resistivities greater than 600 ohm-m could indicate dry sand and gravel or limestone, igneous and metamorphic rocks, or crystalline bedrock underlying Quaternary unconsolidated deposits. The higher the resistivity in the >600 ohm-m range, the less likely that the material is dry unconsolidated sediment, and the more likely that it is bedrock.

Low-resistivity (less than 50 ohm-m) rocks were detected by AMT throughout the study area. This occurrence is consistent with the results of prior TDEM work in Jackson Hole (Nolan and Miller 1995). Values obtained from the literature indicate that shale has a lower resistivity than alluvium and colluvium, whereas marine shale has lower resistivity than sediments of non-marine origin. Keller and Frischknecht (1966) report generalized resistivity ranges of 15–50 ohm-m for sedimentary rocks of Quaternary and Tertiary age, and 5–20 ohm-m for marine sedimentary rocks of Mesozoic age, which includes Cretaceous rocks.

Tertiary rocks exposed east of Jackson Hole include the Tertiary Shooting Iron (Tsi) and Teewinot Formations (Tte: Love et al. 1992). Tsi includes lacustrine and fluvial claystone, siltstone, sandstone, and conglomerate. Minor Tsi exposures also exist on East Gros Ventre Butte (Love et al. 1992) and in the southern part of Jackson Hole (Love and Christiansen 1985). However, the formation is thin (maximum thickness greater than 100 ft, or 30 m; Love et al. 1992) and somewhat scarce in the study area.

The Teewinot Formation consists of limestone, claystone, marlstone, tuff, pumicite, and conglomerate: it crops out near the National Elk Refuge and elsewhere on the eastern margins of Jackson Hole (Love et al. 1992). Tte thickness is reported to be more than 6000 ft (1800 m), and the unit unconformably overlies older Tertiary units beneath it. Although claystone layers in the formation would inhibit groundwater movement, well yields as high as 120 gal/min (7.6 L/s) have been reported for groundwater in solution channels and fractures in limestone (Cox 1976).

Cretaceous formations, several of which are marine, crop out in Jackson Hole and in the mountains east of the valley. The mainly marine Cretaceous formations could represent the lower range of <100 ohm-m layers described in *Table 1*. Marine formations that crop out in eastern Jackson Hole include the Bacon Ridge Sandstone (Kb), the Cody Shale (Kc), and the Frontier Formation (Kf) (Love and Reed 1971). Kb is approximately 1000–1500 ft (300–460 m) thick and is a fine-grained sandstone that contains numerous marine fossils, interbedded layers of brackish-water shale and siltstone, and several coal beds (Love et al. 1992). Kc is approximately 1400–2200 ft (430–670 m) thick and is a marine shale interbedded with smaller amounts of siltstone and glauconitic sandstone. Kf, which also is exposed at the southwestern margin of Jackson Hole (Love and Reed 1971), is about 1000 ft (300 m) thick and consists of sandstone interbedded with shale and thin coal beds (Love et al. 1992). Mainly marine units that are exposed in the southern part of Jackson Hole include the Mowry and Thermopolis Shales (Kmt) (Love and Reed

Table 1 Subsurface lithology and associated, generalized electrical resistivity ranges in the southern part of Jackson Hole, Wyoming, USA

Electrical resistivity, ohm-meters	Subsurface lithology
<100	Fine-grained, saturated deposits such as silt and clay (e.g., lacustrine deposits); sedimentary rocks such as claystone, siltstone, shale, or sandstone; very low values (<20 ohm-meters) suggest marine shale
100–600	Jackson aquifer, comprising coarse-grained unconsolidated materials in alluvium, colluvium, and gravel, pediment, and fan deposits; saturated with high-quality water
>600	Dry sand and gravel; limestone; igneous and metamorphic rocks; very high values (>1000 ohm-meters) suggest crystalline bedrock

Table 2 Semivariogram model parameters and cross-validation criteria for variable AQUIF, describing the depth to the bottom of the 100–600 ohm-m geoelectric layer representing the Jackson aquifer

Semivariogram model type	Nugget	Sill	Range	Average kriging error	Mean square error	Mean square reduced error
(a) Spherical	0.532	0.892	5.97 mi (9610 m)	−0.020	0.756	0.9[illegible]
(b) Spherical	0.500	0.850	6.21 mi (10,000 m)	−0.020	0.756	0.940

sample must be perfectly correlated with itself. In practice, however, a fitted semivariogram might yield a nonzero or nugget value at the plot origin. The nugget represents random variation (e.g., measurement error) within the smallest sampling interval.

The experimental semivariogram for AQUIF appears stable about the sill, as shown in *Figure 4*. The experimental semivariogram is indicated by the individual points in *Figure 4*. Semivariances at separation distances greater than 12 mi (19 km) have only 18–34 pairs of observations. Because of the small number of pairs, semivariances at distances greater than 12 mi (19 km) were not used when manually adjusting model semivariograms for use in kriging.

In kriging, a model semivariogram fitted to the experimental data is used to calculate weights used in the kriging prediction. Cross-validation, a technique that measures the difference between observed and kriged values for a partitioned data set, typically is used to test competing semivariogram models before selecting one for use in kriging. Cross-validation criteria used in this study were designated (1) the average kriging error (AKE); (2) the mean square error, or variance of kriging errors (MSE); and (3) the mean square reduced error (MSRE), or standard deviation of the ratio of kriging errors to kriging standard deviations (Davis 1987; Jury et al. 1987; Cooper and Istok 1988). The kriging

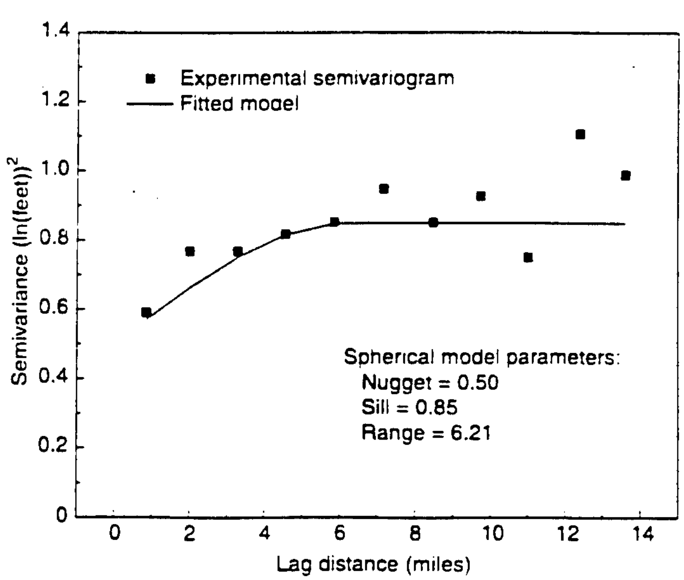

Fig. 4 Experimental and fitted semivariograms of depth, in units of $[\ln(\text{feet})]^2$, to the base of the Jackson aquifer.

error is the difference between an observed value and the kriged prediction when the observed value is suppressed and treated as an unknown. The AKE should have a value of about zero, the MSE should be less than the sample variance (0.804), and the MSRE should have a value of about one. Competing semivariogram models are shown in *Table 2*, along with model parameters and cross-validation criteria.

Semivariogram model (2), used in subsequent kriging, is shown by the smooth curve in *Figure 4*, along with the corresponding experimental semivariogram. This semivariogram model was considered reasonable, based on the cross-validation criteria. Because the AKE and MSE were the same for each model, the assumed "best" model was that which resulted in improvement of the MSRE. Model (2) had a mean square reduced error (0.940) closer to one. Additionally, visual inspection of *Figure 4* indicated that semivariogram model (2) fitted the experimental semivariances reasonably well.

Figure 5 shows the kriged contours of the depth (in feet) to the base of the Jackson aquifer. The contour maps were produced from the gridded kriging predictions using methods recommended by Shan and Stephens (1994). The contours indicate that aquifer thickness is relatively small in the central part of the study area near the Gros Ventre Buttes, larger in the west near the town of Wilson, and relatively small at the southern edge of the study area. Predicted, contoured depths to the base of the Jackson aquifer range from 100 ft (30 m) in the south, near the confluences of Spring Creek and Flat Creek with the Snake River, to 700 ft (210 m) in the western part of the study area, near the town of Wilson.

In general, AMT indicates that the Jackson aquifer is thicker in the western part of the study area along the Teton fault system, an active fault at the western edge of Jackson Hole. The Teton fault, which has offset rates of 0.039–0.059 in (0.10–0.15 cm) per year (Pierce and Good 1992), extends north and south in the study area along the western edge of Quaternary alluvium, gravel and sand, and flood-plain deposits (Love et al. 1992). Beds of sedimentary rock, originally deposited horizontally, now dip westward toward the Teton fault. The dip of the units suggests that basin fill is thicker in the western part of Jackson Hole. For example, the Tertiary Teewinot Formation and Huckleberry Ridge Tuff (Thr) have dips of 22° in northern Jackson Hole near the eastern shore of Jackson Lake, about 8 miles

Summary

Audio-magnetotellurics (AMT) measurements were made in the southern part of Jackson Hole, Wyoming, to estimate the thickness of the water-table aquifer. A resistivity range of 100–600 ohm-m was used to estimate the depth of the base of surficial, saturated deposits of Quaternary age, designated the Jackson aquifer. The median depth to the base of the aquifer is estimated to be 200 ft (61 m). Contour maps of kriging predictions of depth values indicate that aquifer thickness is relatively small in the central part of the study area near the Gros Ventre Buttes, greater in the west near the Teton fault, and relatively small at the southern edge of the valley. Predicted, contoured depths to the base of the aquifer range from 100 ft (30 m) in the south, near the confluences of Spring Creek and Flat Creek with the Snake River, to 700 ft (210 m) in the west, near the town of Wilson, Wyoming.

Acknowledgments The authors gratefully acknowledge the Teton County Natural Resource District and the Jackson Hole Baseline Research Foundation, who provided support for this project. Also thanked are the numerous landowners in Jackson Hole, Wyoming, who graciously provided access to their lands for data collection. Without their cooperation, completion of this study would have been impossible. Thanks also to Michael Karlinger, who provided valuable assistance during the geostatistical analysis of the data, and Kenneth Pierce, who provided valuable insight into the Quaternary geology of the study area.

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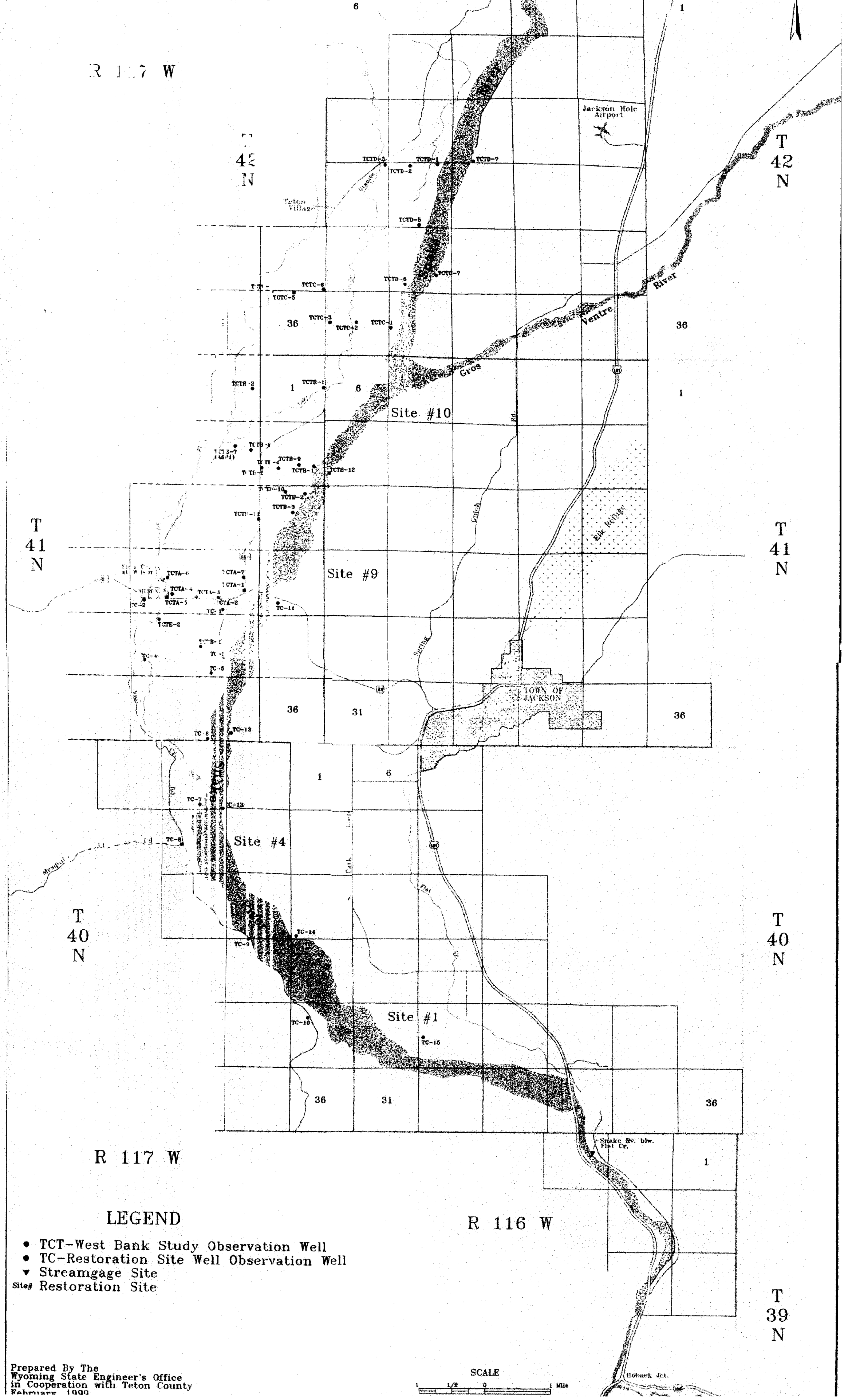
PART IV. MONITORING SYSTEM

a) Location Map

The location map identifies the location of the fifty (50) observation wells and the two stream gauge station referenced in this report, Flat Creek below Jackson and Fish Creek at Wilson.

Location Map for Teton County Observation Wells, Streamgages and Restoration Sites



PART IV. MONITORING SYSTEM

b) Observation Wells - Ground Water

The Observation Wells are 6" perforated casing set at approximately 20' deep. Each well is equipped with a continual recording device that can be down loaded periodically throughout the year. Although the initial thirty-five (35) well sites were not installed for the JHERS it was obvious this data will be beneficial to this study and is included in this report. The remaining fifteen (15) wells have a very short record thus it will be necessary to continue operation of these wells as well as the original thirty-five (35) wells into the future to establish a reasonable data base for this system.

PART IV. MONITORING SYSTEM

c) Gauge Station and Staff Gauges

Surface Water

When the initial Westbank issue raised in the early 1990's, surface water uses in the valley was claimed to be a cause of the perceived ground water problem. In order to provide a more comprehensive data base, a surface water monitoring system was established. Through a co-op arrangement between the USGS and the Teton County Natural Resource District stream gauging stations were installed on Fish Creek near Wilson, Granite Creek above the Granite Creek Supplemental Supply Canal and two on the Granite Creek Supplemental Supply Canal as well as one staff gauge on "Lake" or Granite Creek at Hwy. 390.

The Wyoming State Engineer's Office Surface Water Division expanded this system by installing staff gauges on five (5) irrigation diversions, two (2) staff gauges on Fish Creek and two (2) staff gauges on Lake Creek. The surface water monitoring is necessary to document surface water impact to the area, as well as surface water discharge from the area.

PART V. GROUND WATER DATA

a) Westbank Observation Well Hydrographs

1. TCTA 1 through TCTA 7
2. TCTB 1 through TCTB 12
3. TCTC 1 through TCTC 7
4. TCTD 1 through TCTD 7
5. TCTE 1 through TCTE 2
6. TCTR 1 through TCTR 2

Observation Well Explanation Sheet

The data presented for the observation wells represents the entire period of measurement record. Well locations are based on the Federal system of land subdivision. The first number denotes the township north of the 40th Parallel Base Line, the second number denotes the range west of the Sixth Principal Meridian, and the third number denotes the section. A section is divided into quarters of 160 acres each; each quarter is designated a, b, c, or d in a counterclockwise direction, beginning in the northeast quarter. Each quarter is divided into quarters of 40 acres each and again into quarters (10-acres tracts). Alphabetical designations are also assigned to the subsequent subdivisions. A numeral appearing after the letters distinguishes that well from other numbered wells within the same 10-acre tract. Figure (1) illustration shows the location of a well located in 12-60-07ddd01 in Laramie County.

Observation well construction consisted of twenty foot (20') sections of 6-5/8" O.D. steel casing. Each joint of casing had a 12" point manufactured by State Engineer staff and 25 torch slotted perforations cut into the casing. The casing was placed into the ground using a track hoe with a vibrator shoe to drive each well point. All wells are equipped with a Telog 2100e electronic data logger with 5 and 10 PSI transducers on 20 foot cables. The loggers are programmed to take water level measurements every hour of every day then average the readings over a 24 hour period. All well location elevations were calculated using a Global Positioning System (GPS).

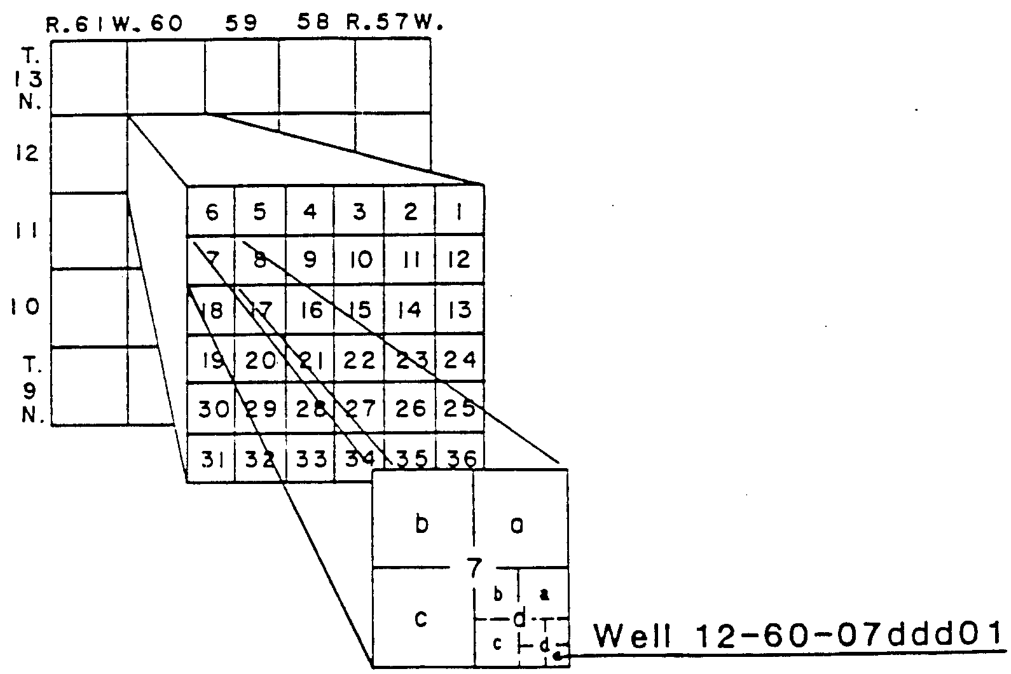
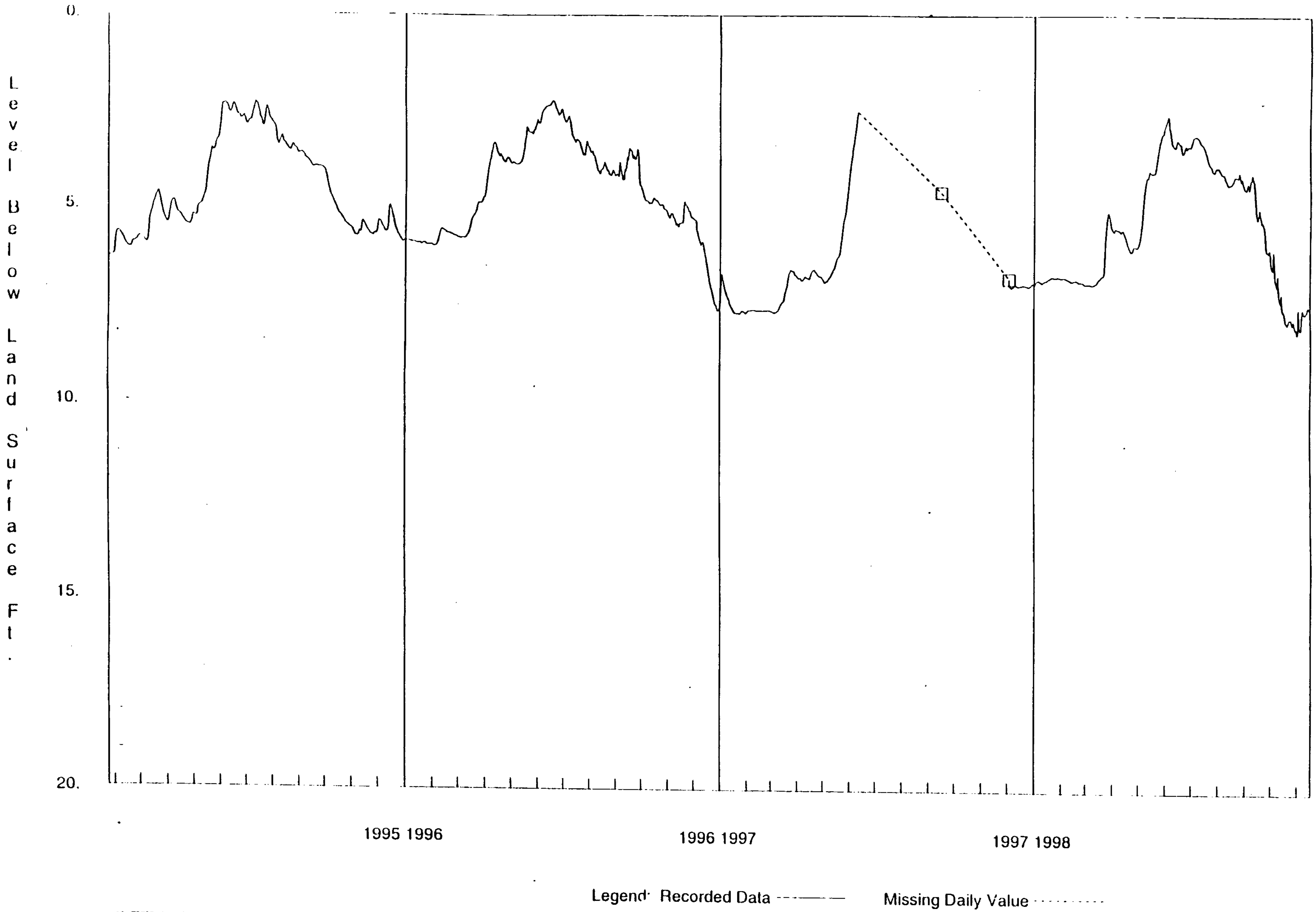


Figure (1).

41 117-23dab Teton ity 432 0110504700



Prepared by the Wyoming State E eer's Offi

TCTA-1

41 117-23cac

Teton County

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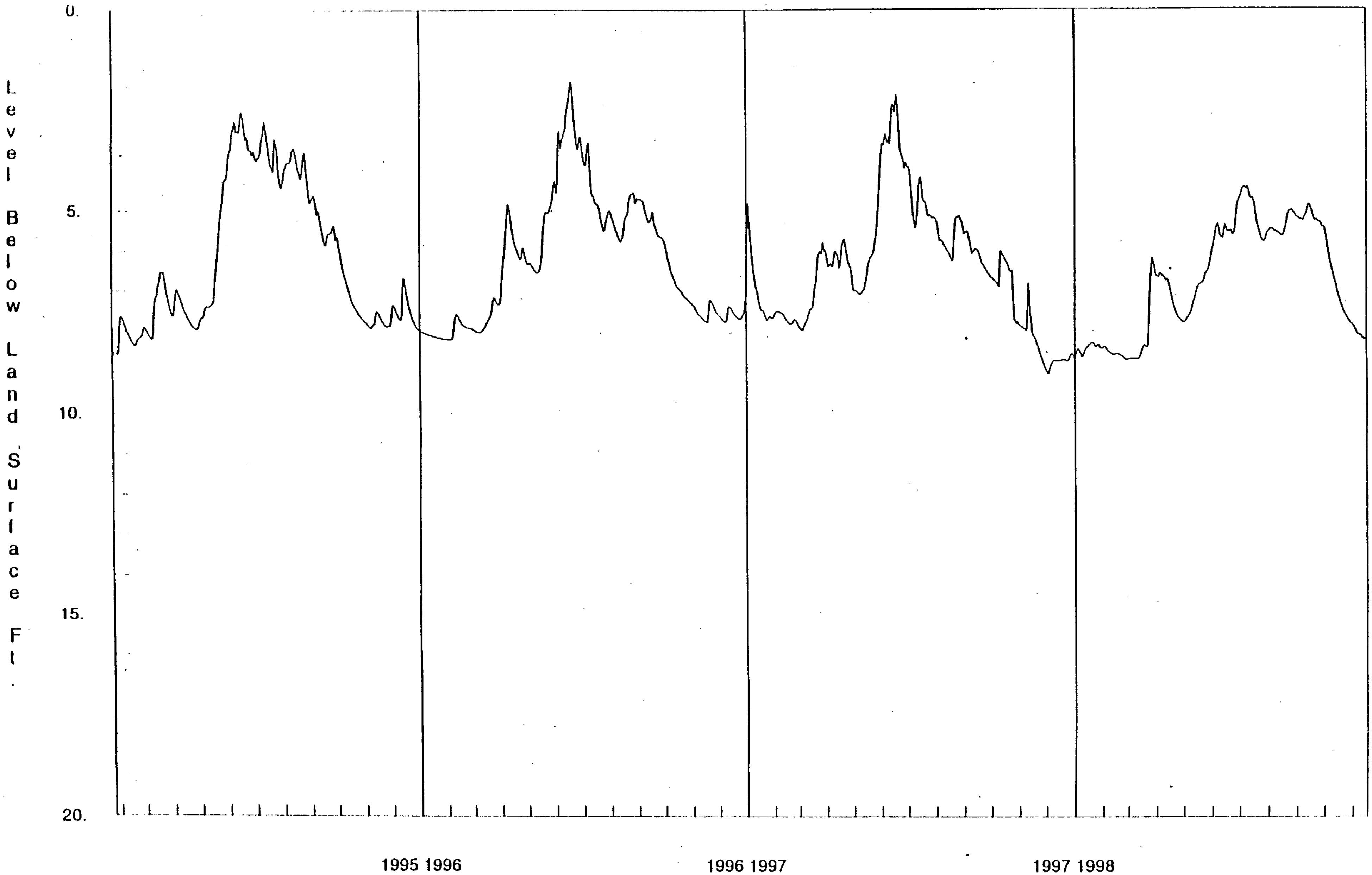
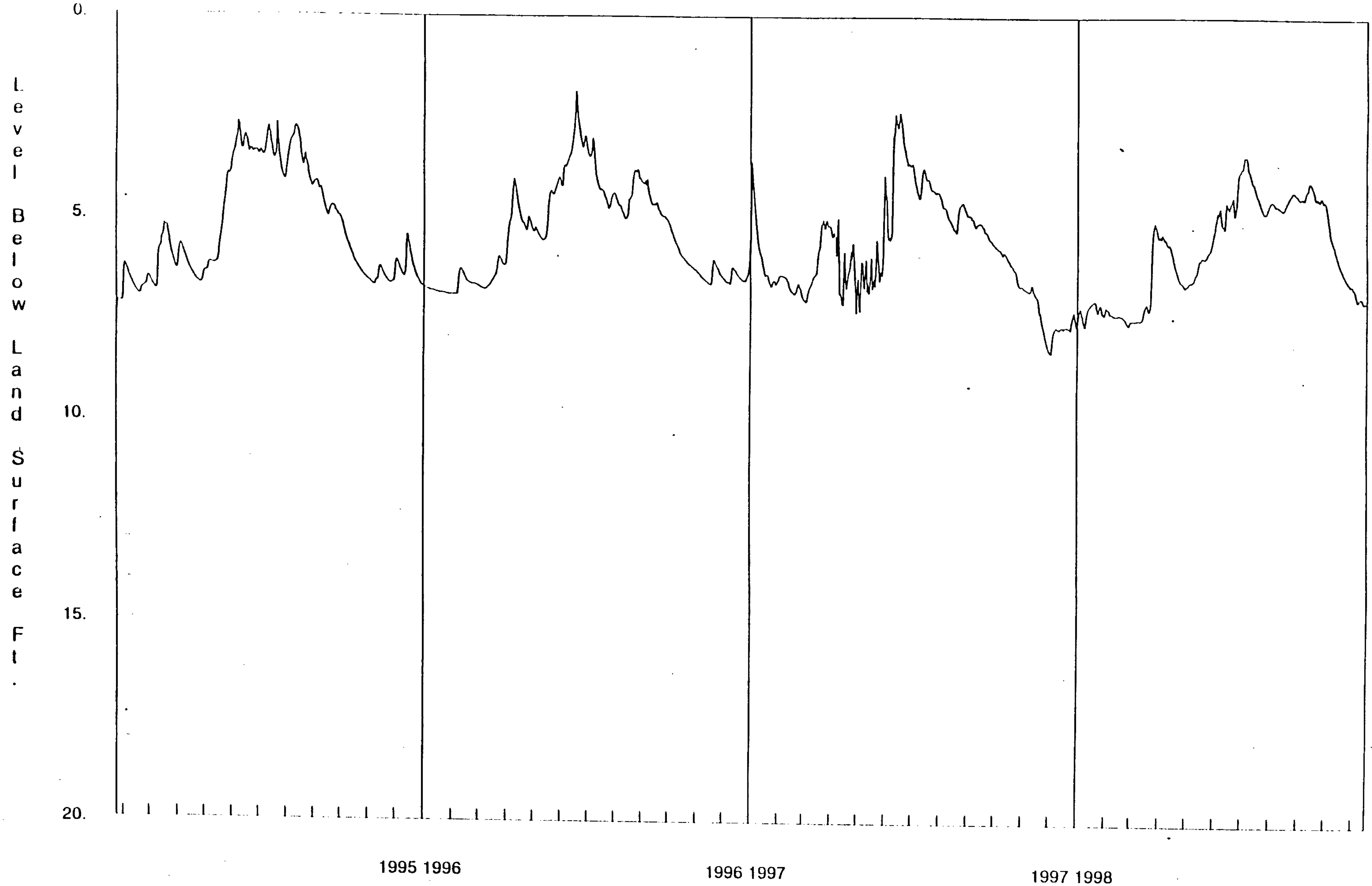


TCTA-2

Legend Recorded Data ————

Prepared by the Wyoming State Engineer's Office
in Cooperation with Teton County Februar

·41 117-23cbc Teto[illegible] ınty 43[illegible]4110514300



Legend: Recorded Data ———

TCTA-3

Prepared by the Wyoming Star~ Engineer's Office in Cooperation with on County

Teton County

41 117 22dbd

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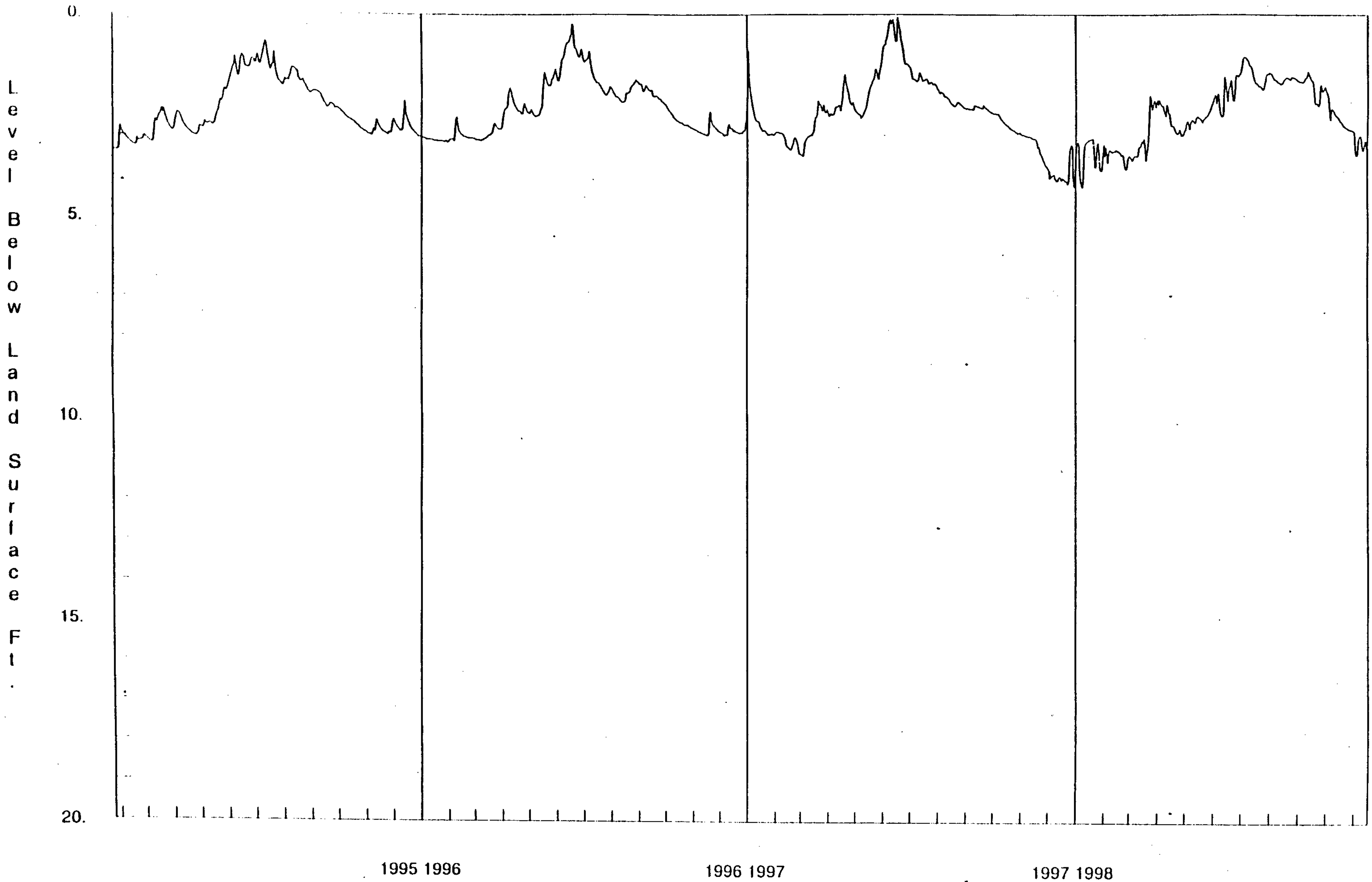


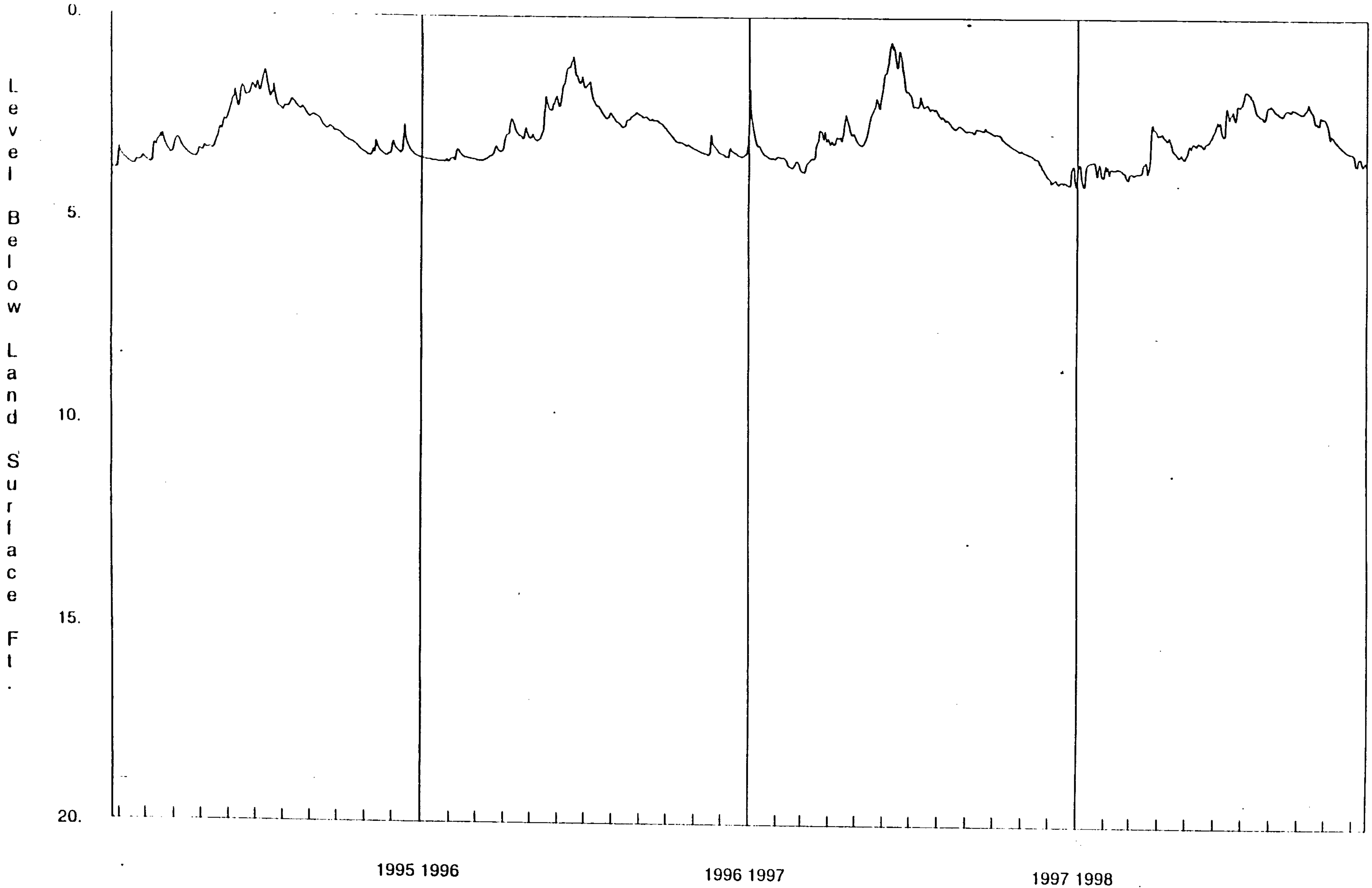
TCTA-4

Prepared by the Wyoming ... e Engineer's Office in Cooperation wi... eton County
February 1999

41 117 22dbc

Teto[illegible]nty

4[illegible]3110521400



TCTA-5

Prepared by the Wyoming Sta[illegible] Engineer's Office in Cooperation with [illegible]on County

Teton County

41 117 22acc

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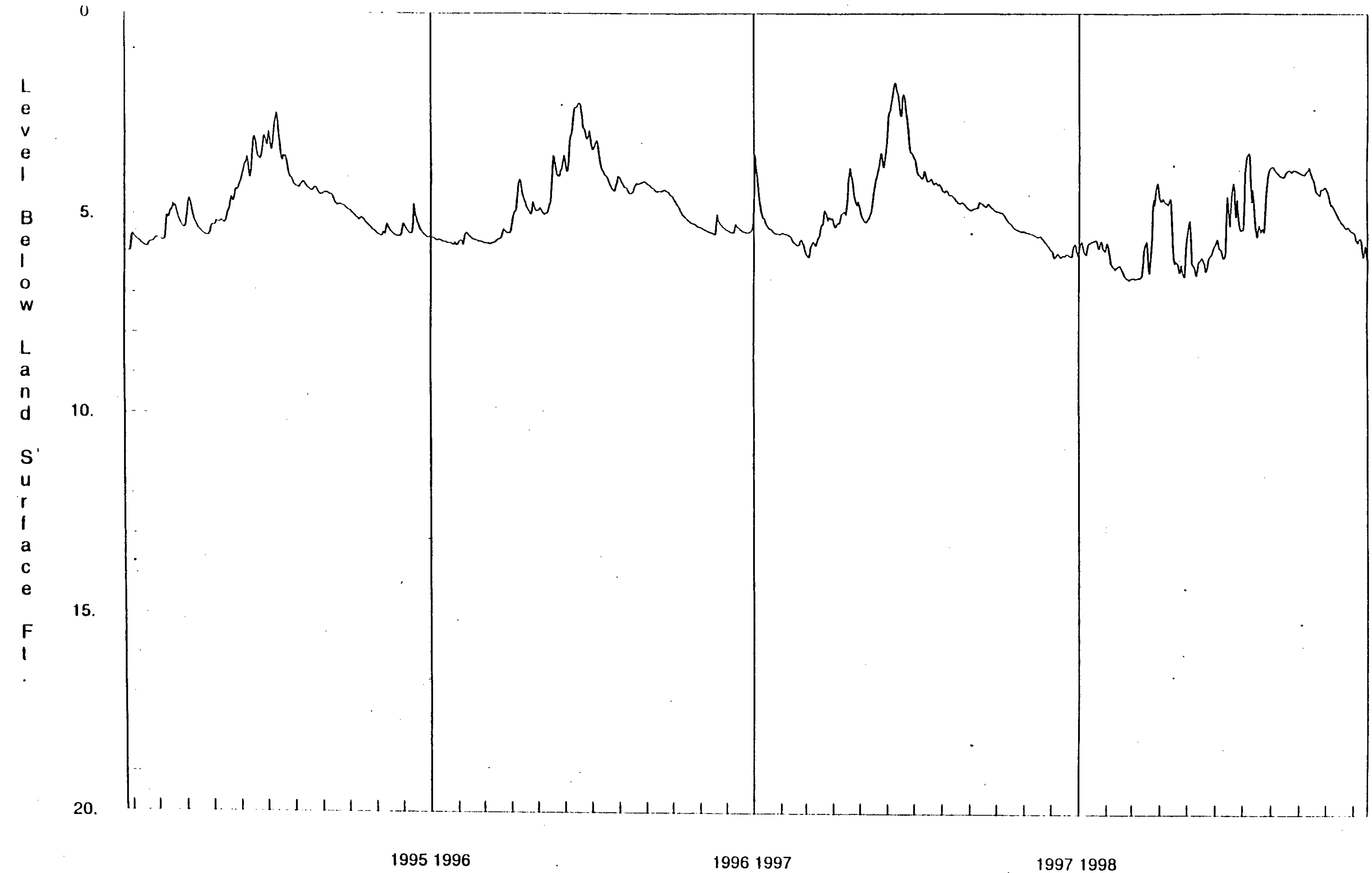

TCTA-6

Lege Recorded Data ————

Prepared by the Wyoming S Engineer's
Office in Cooperation wit on County

41 117-23adc

Teto[illegible]unty

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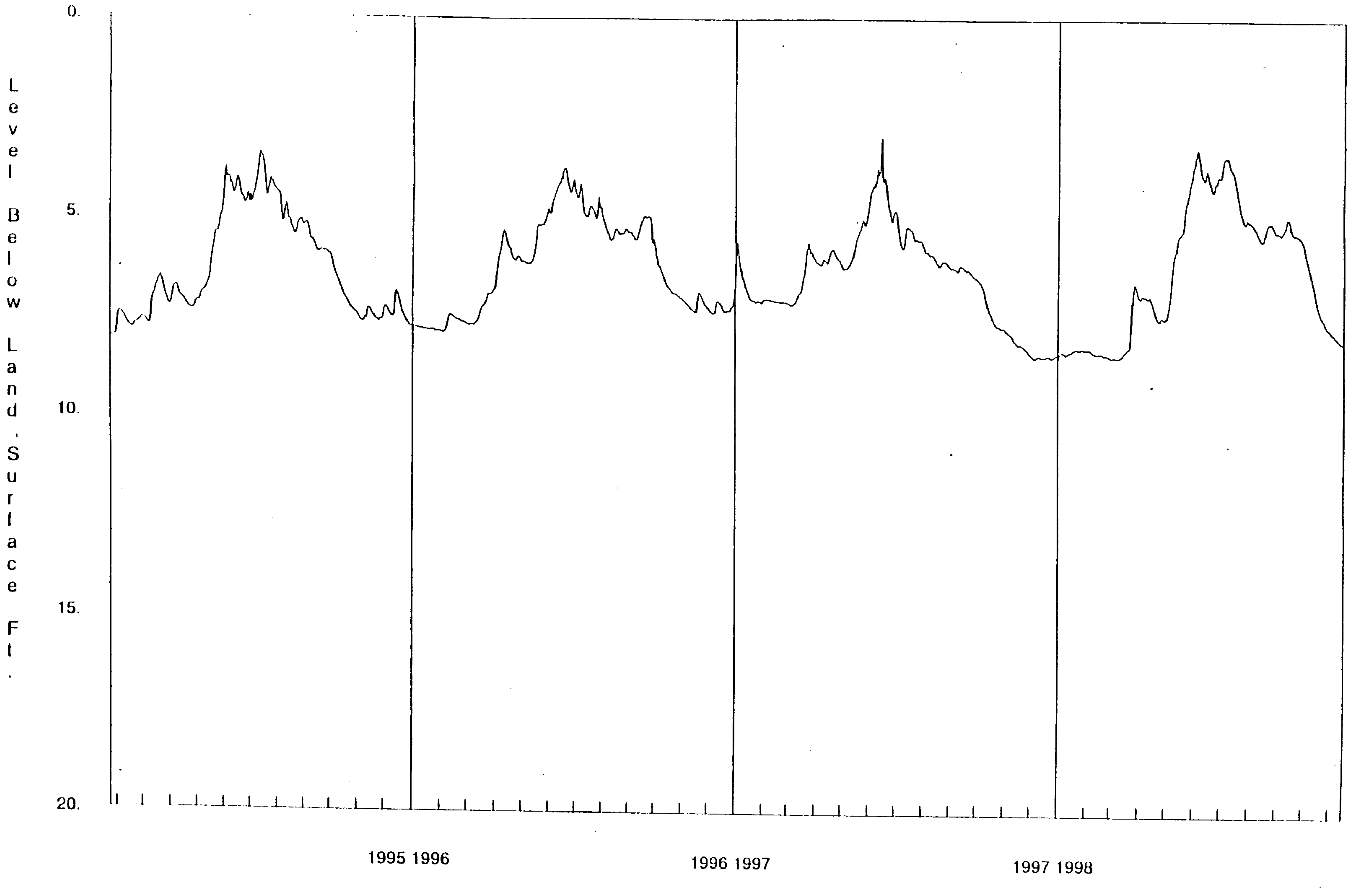

TCTA-7

Prepared by the Wyoming St[illegible] Engineer's Office in Cooperation with [illegible]ton County

Teton County

41 117-12dda

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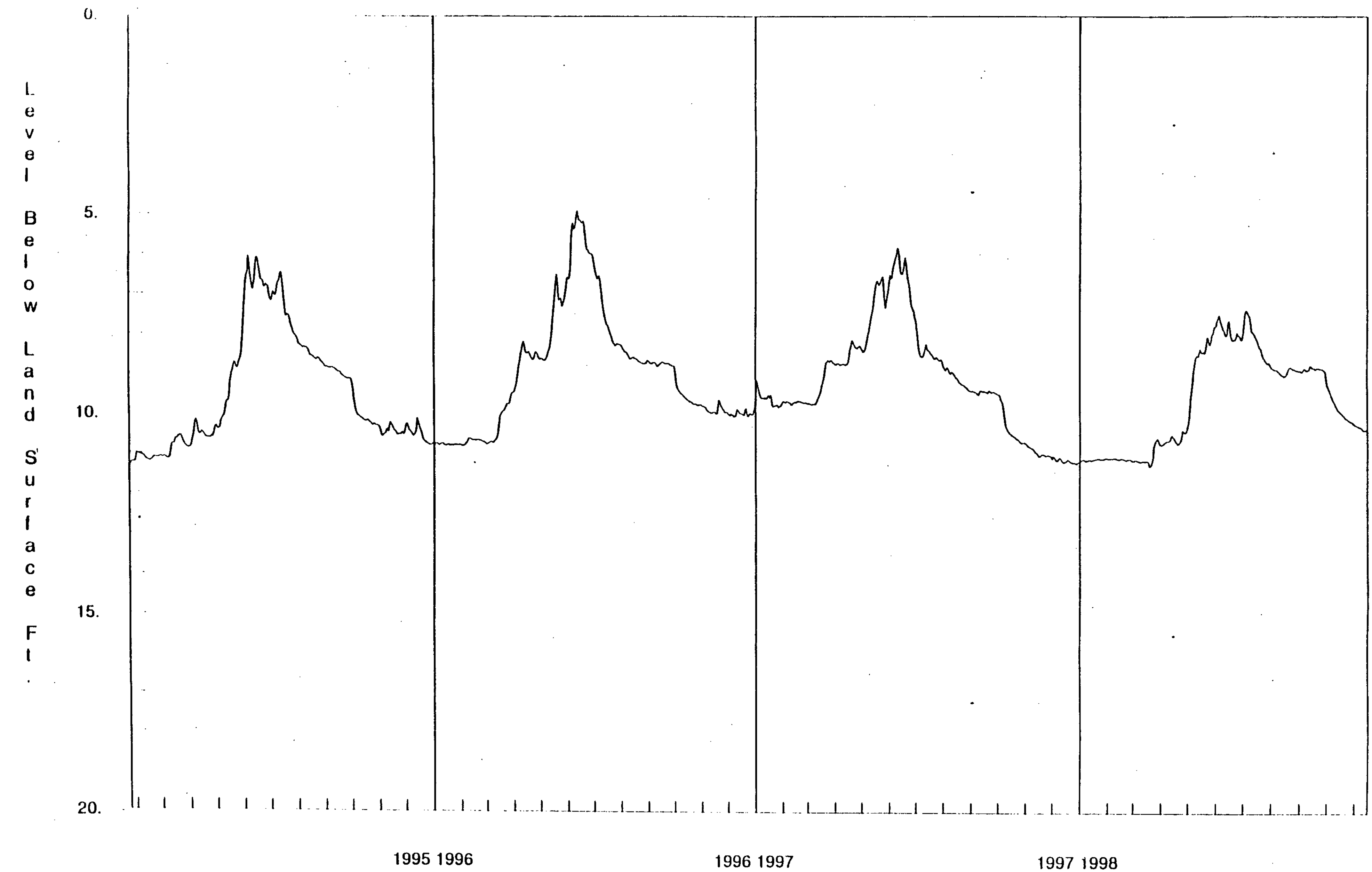
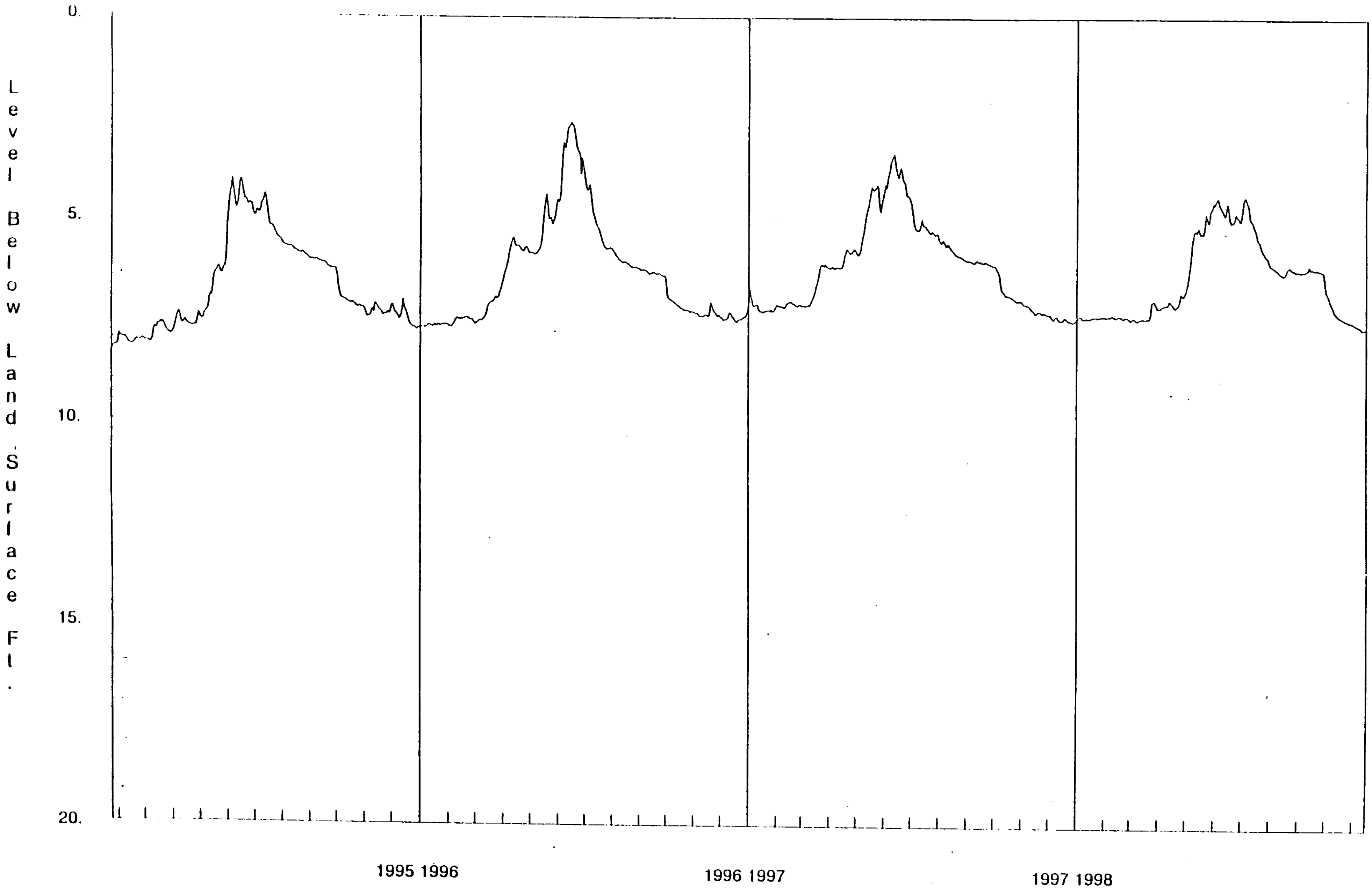


TCTB-1

Leg Recorded Data

Prepared by the Wyoming S Engineer's
Office in Cooperation wit ton County

41 117-13aba Teto anty 4 18110493900



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Prepared by the Wyoming State Engineer's Office in Cooperation with ' on County

TCTB-2

Teton County

41-117-13acc

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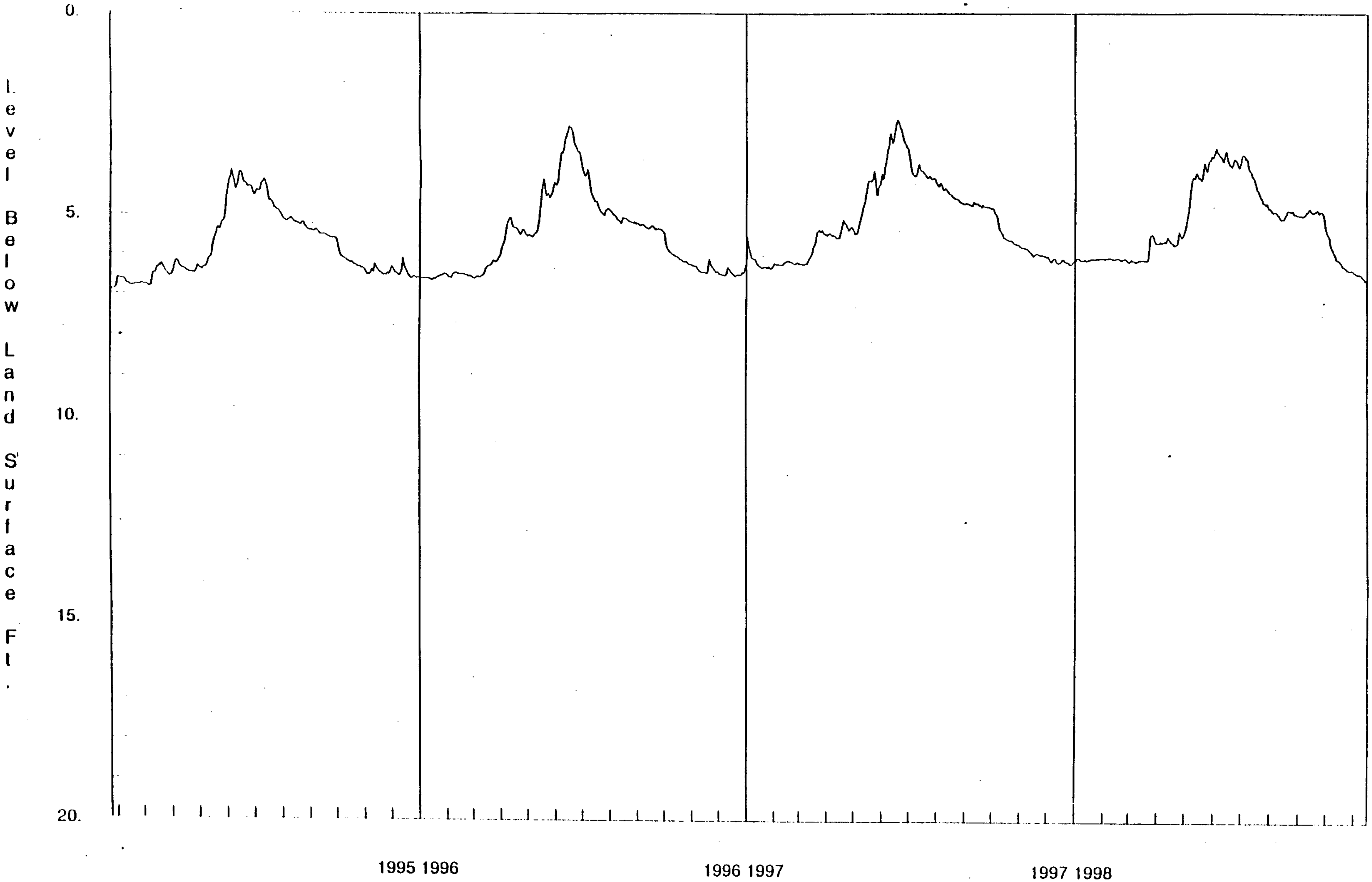

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Leg Recorded Data

Prepared by the Wyoming Sta ngineer's
Office in Cooperation with n County

41 117-12cdb

Teto unty

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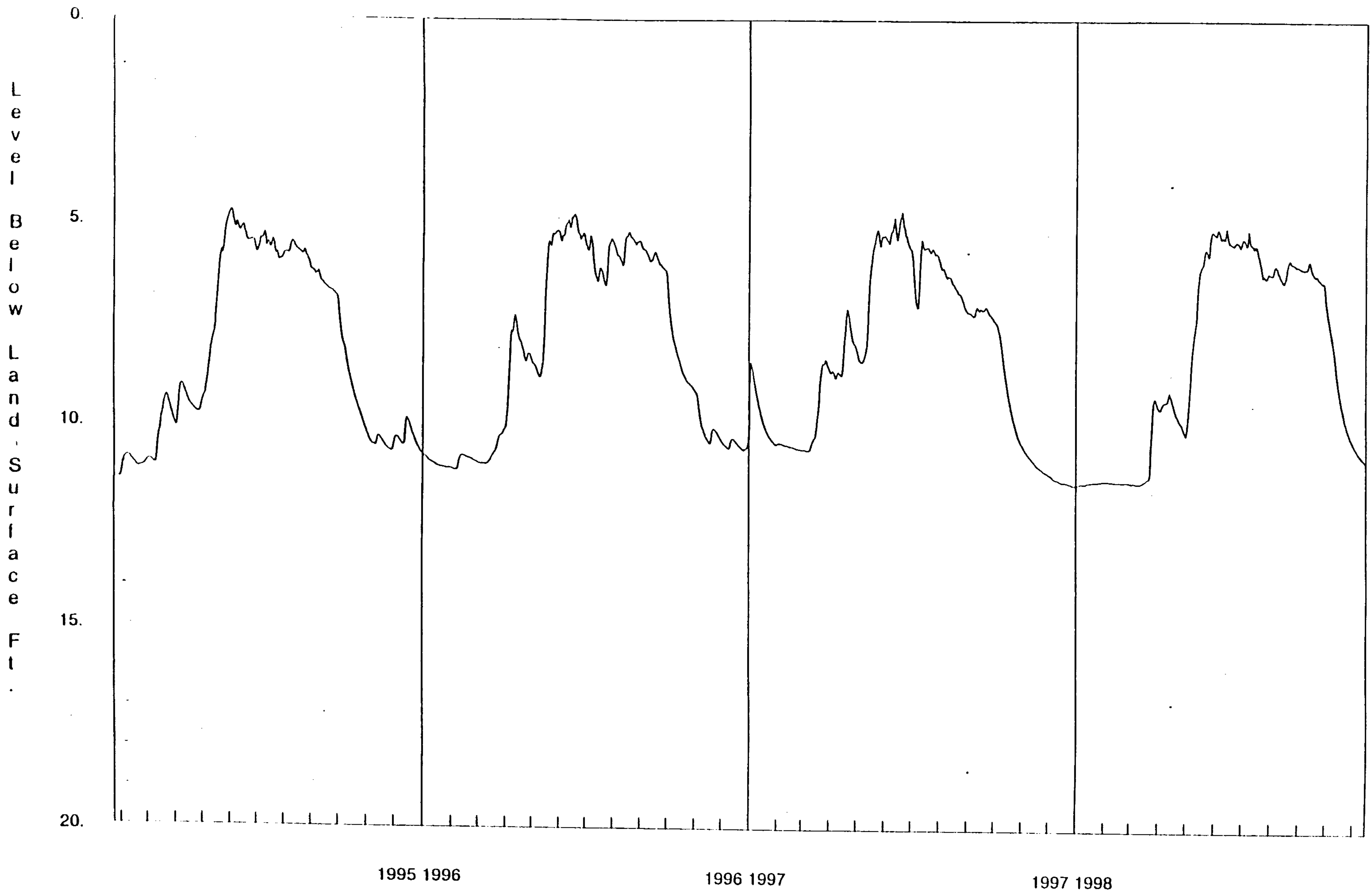

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TCTB-4

Prepared by the Wyoming State Engineer's Office in Cooperation with :on County

Teton County

41 117 12ccb

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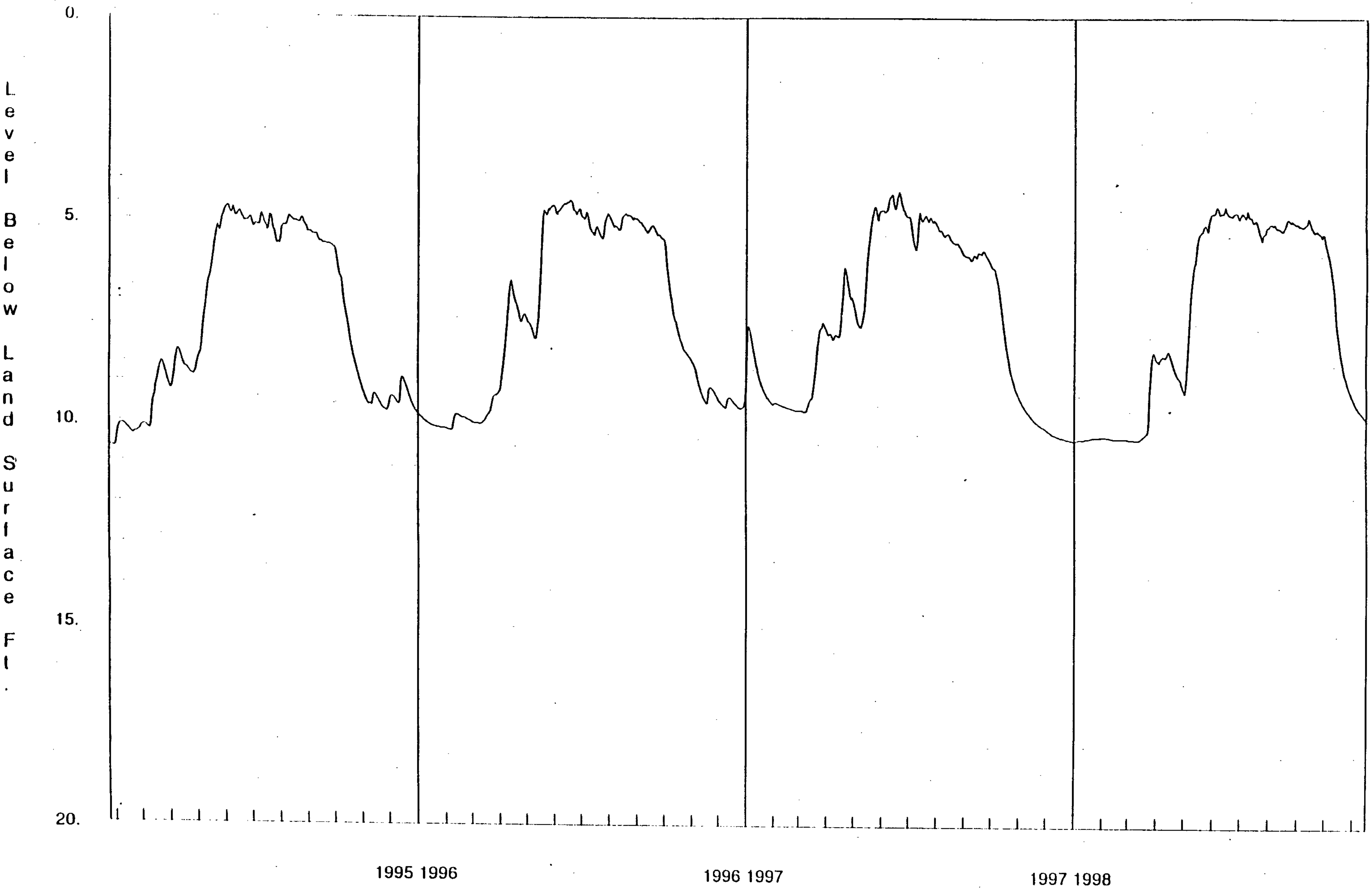


TCTB-5

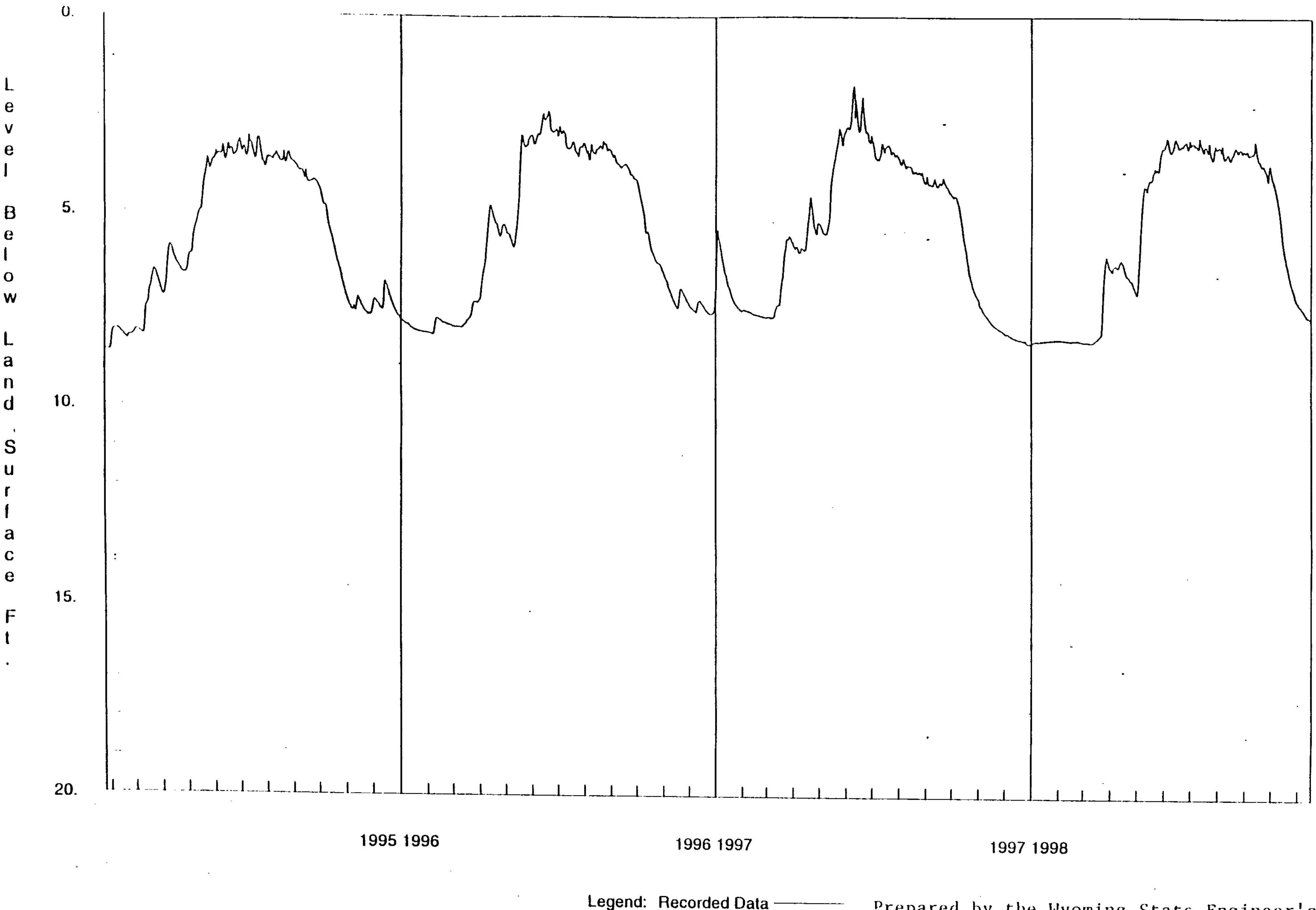
Legend Recorded Data ————

Prepared by the Wyoming State Engineer's Office in Cooperation with Teton County

41 117-11add

Teton .nty

43 0110503700



TCTB-6

Prepared by the Wyoming Stat Engineer's
Office in Cooperation with n County

41 117 Haed

Teton County

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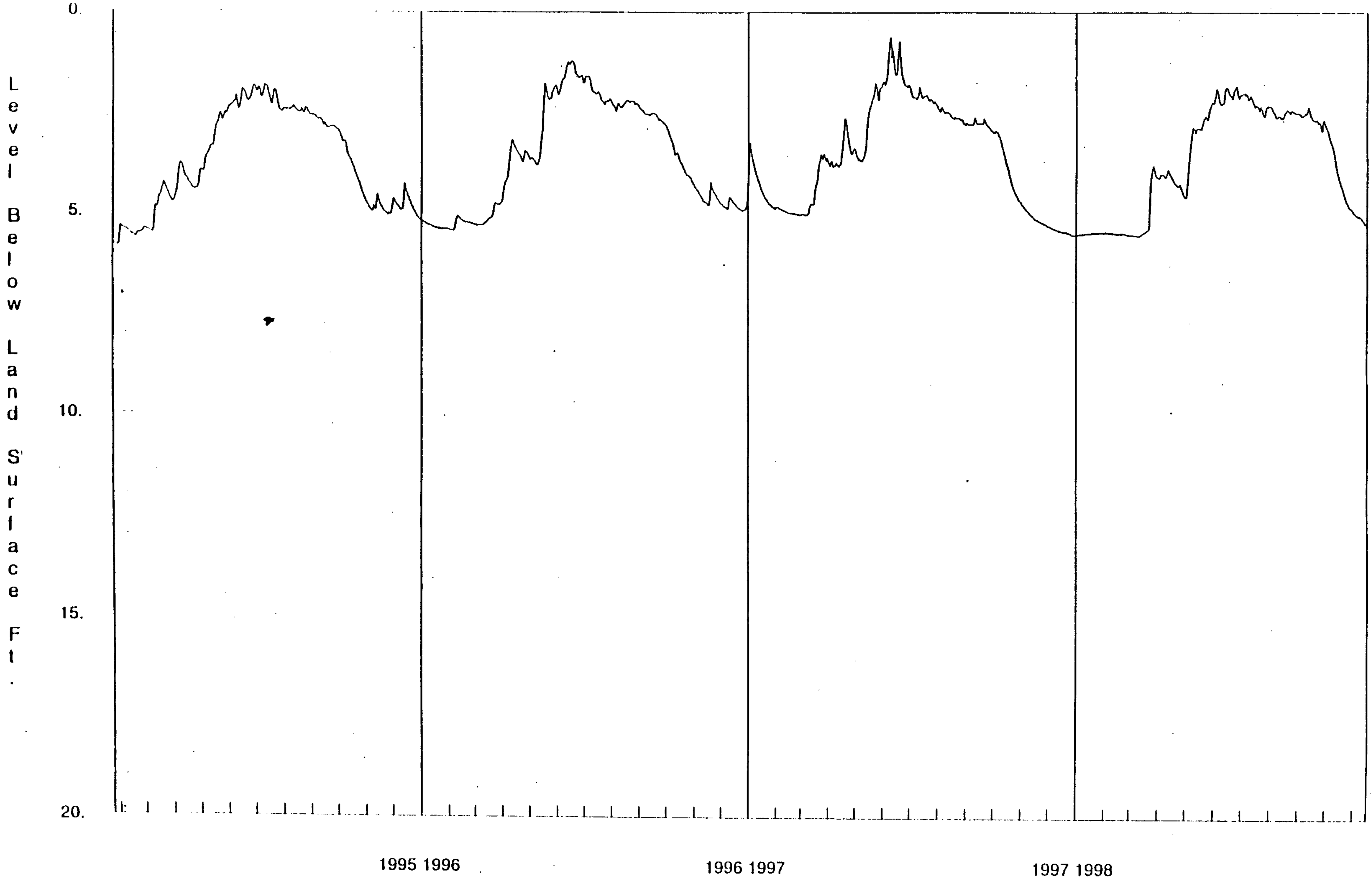

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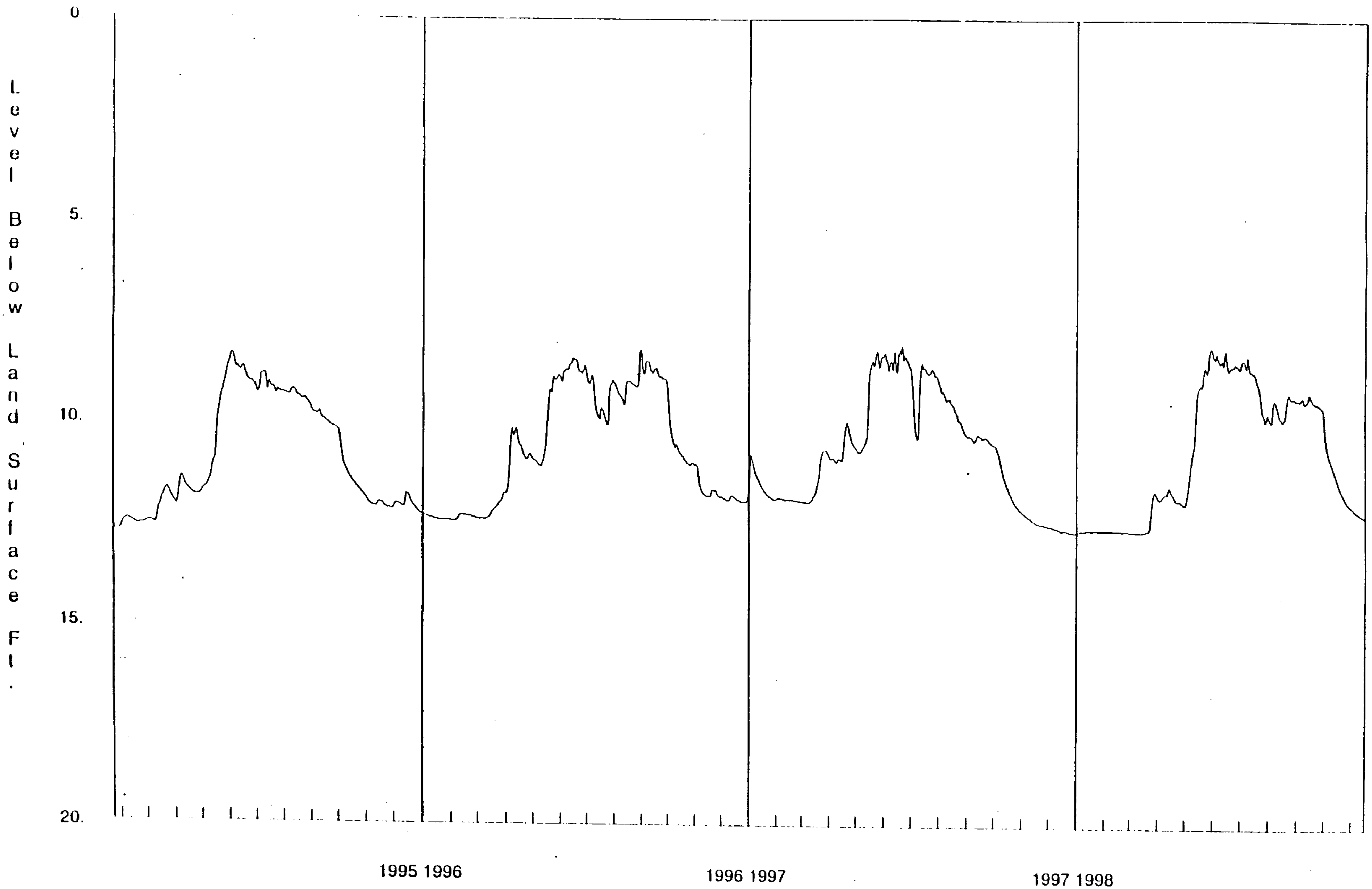
Legend Recorded Data ————

Prepared by the Wyoming St Engineer's
Office in Cooperation with on County



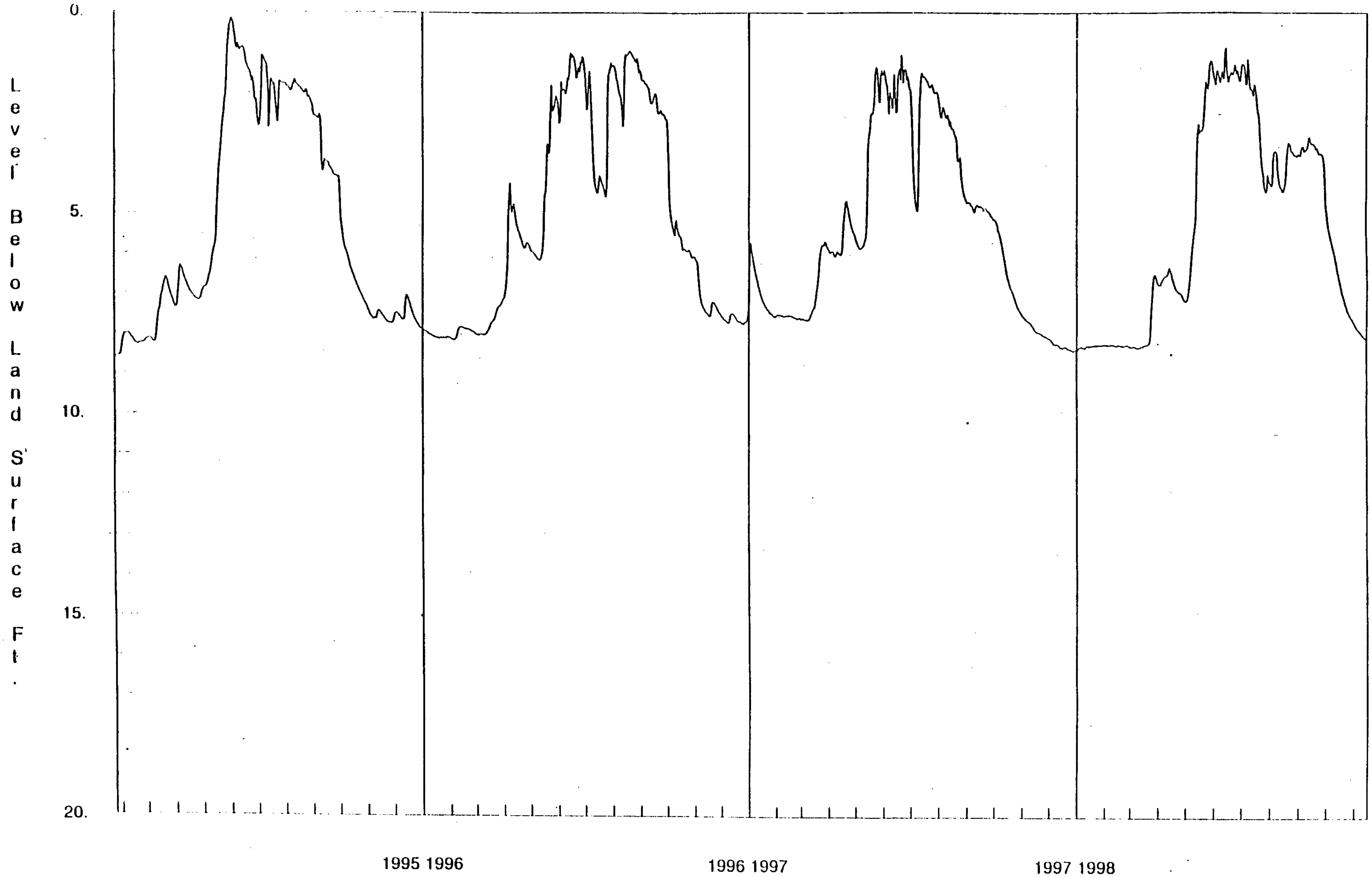
Prepared by the Wyoming Stat Engineer's
Office in Cooperation with

TCTB-9

Teton County

41 117 13baa

433121110500200



Leg Recorded Data

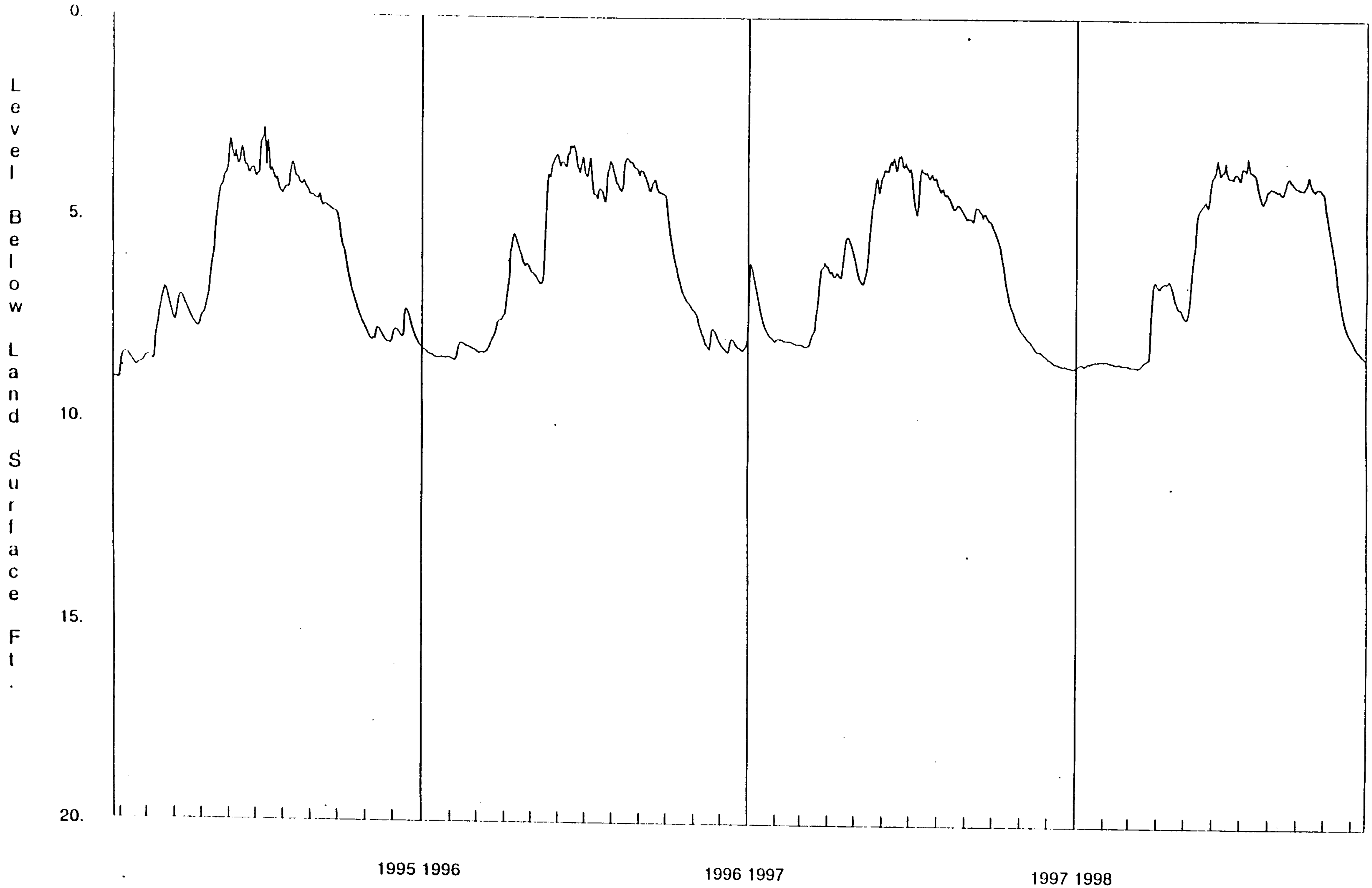
Prepared by the Wyoming S Engineer's Office in Cooperation wit on County

TCTB-10

41 117 Hadd

Teto nty

43 58110503300



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Prepared by the Wyoming State Engineer's
Office in Cooperation with ton County

41 116 7ccb

Teton County

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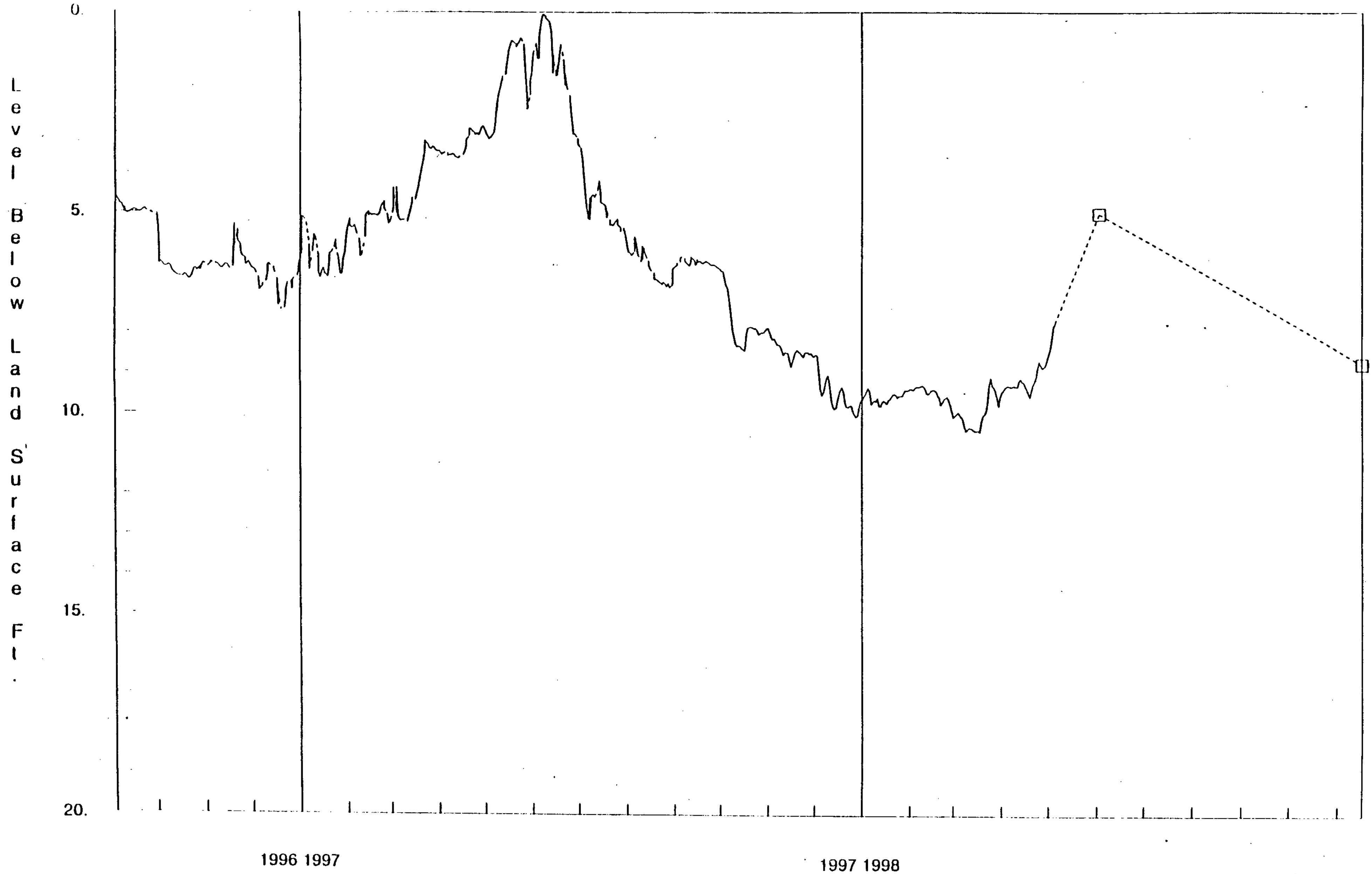

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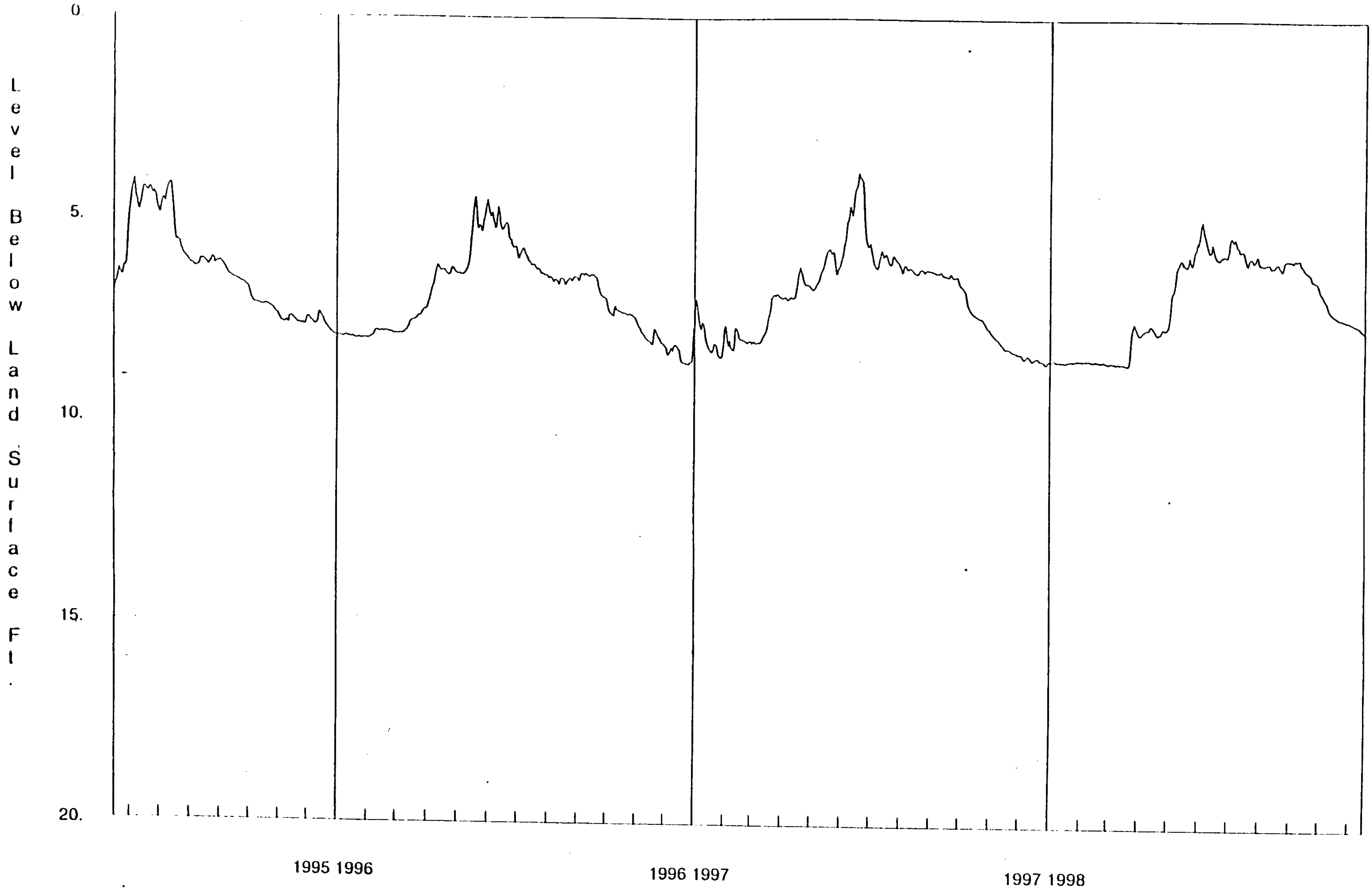
Hand Measurement □ Prepared by the Wyoming State ineer's

-42 116-32cbc Teto inty 43 28110480900



Legend: Recorded Data ————

TCTC-1

Prepared by the Wyoming Sta Engineer's
Office in Cooperation with on County

42 116-31bdd

Teton County

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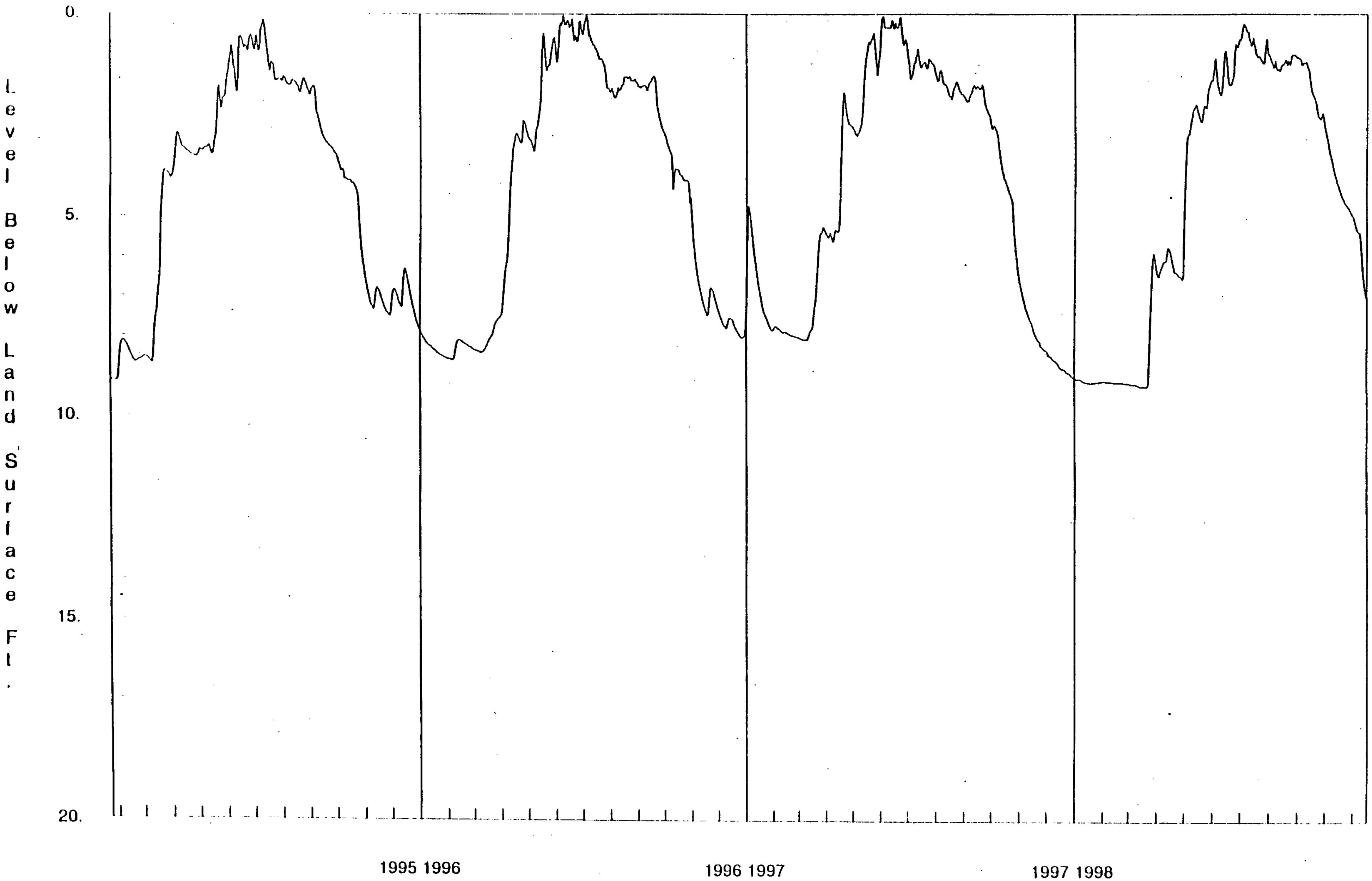


TCTC-2

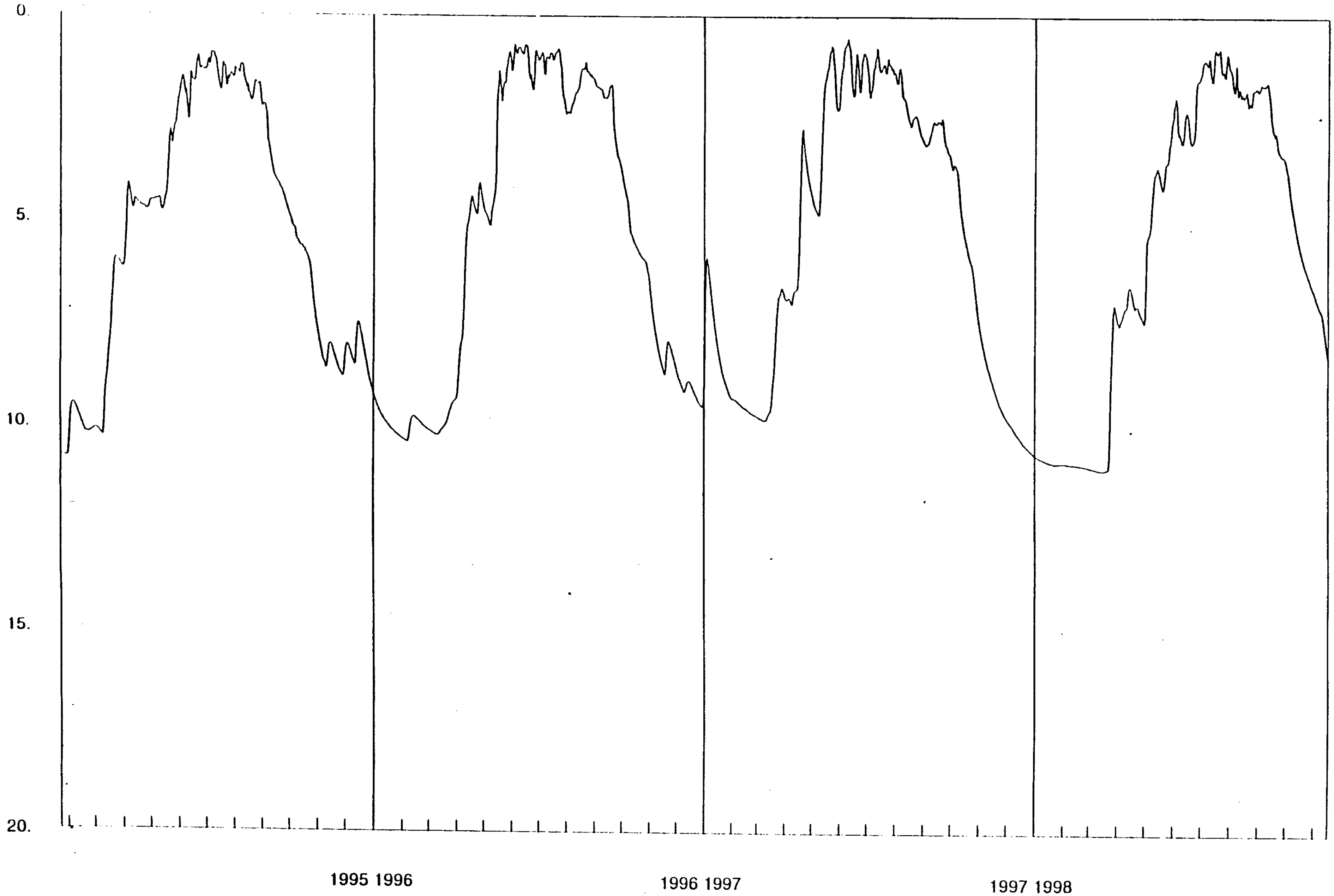
Leg Recorded Data ———

Prepared by the Wyoming St Engineer's
Office in Cooperation with on County

12 116 31cbb

Teton nty

43 6110491400



Legend: Recorded Data

TCTC-3

Prepared by the Wyoming State ngineer's
Office in Cooperation with T a County

Teton County

42 117-36bba

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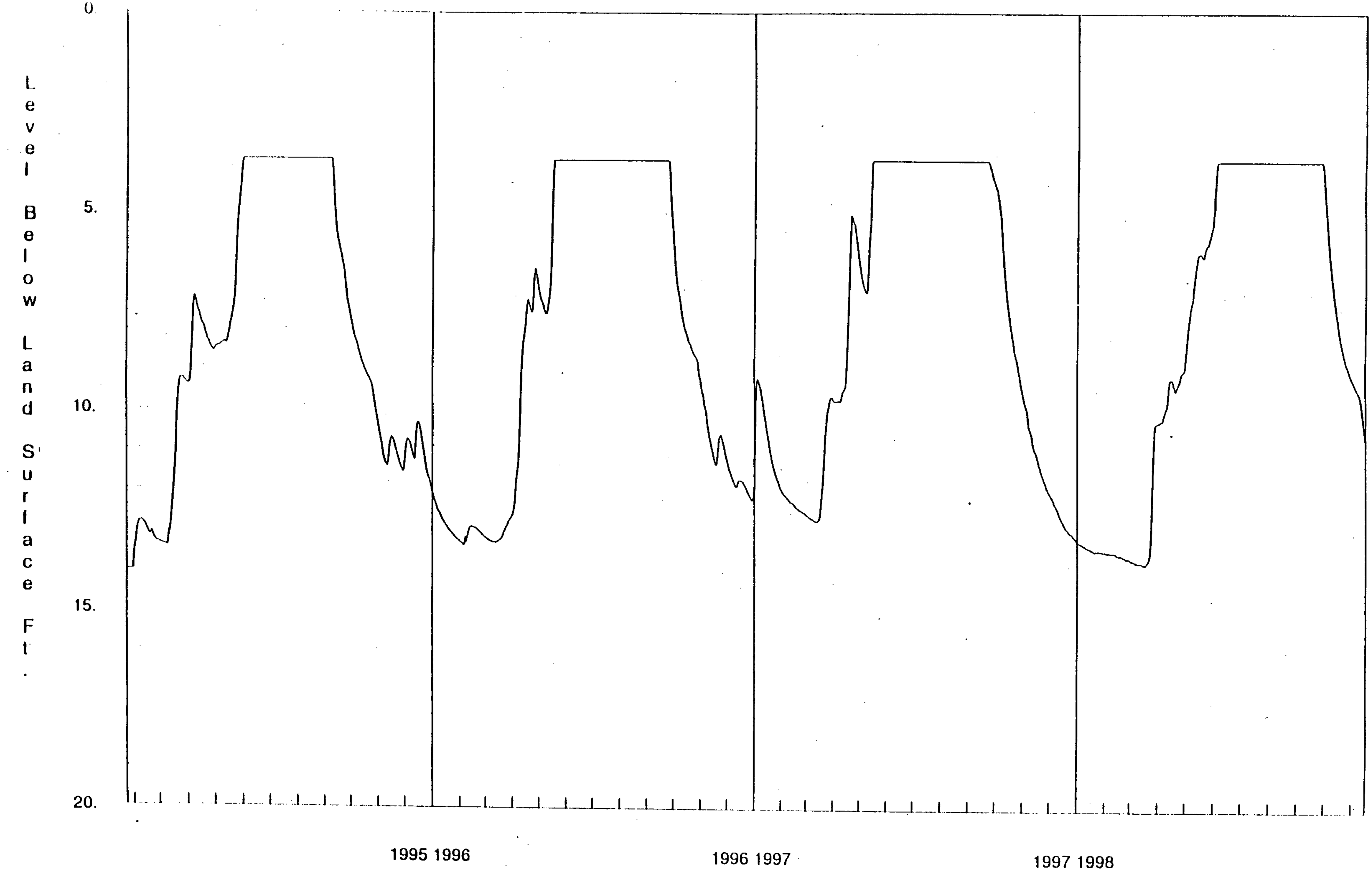
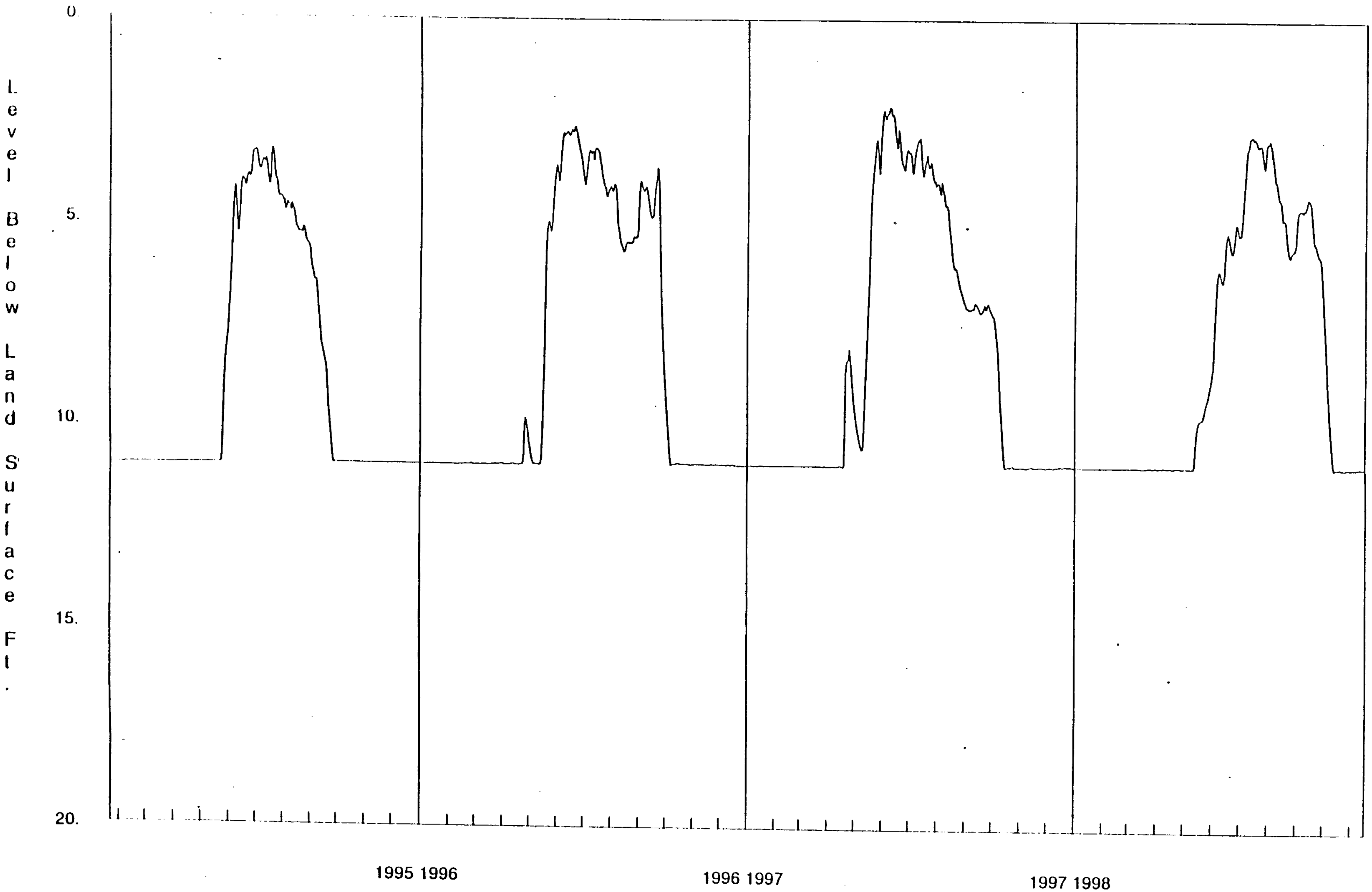


TCTC-4

Lege   ecorded Data

Prepared by the Wyoming Stat   gineer's
Office in Cooperation with T   County

12 117 36baa Teton nty 43 2110495500



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Prepared by the Wyoming State Engineer's Office in Cooperation with on County

Teton County

42 117 25ddd

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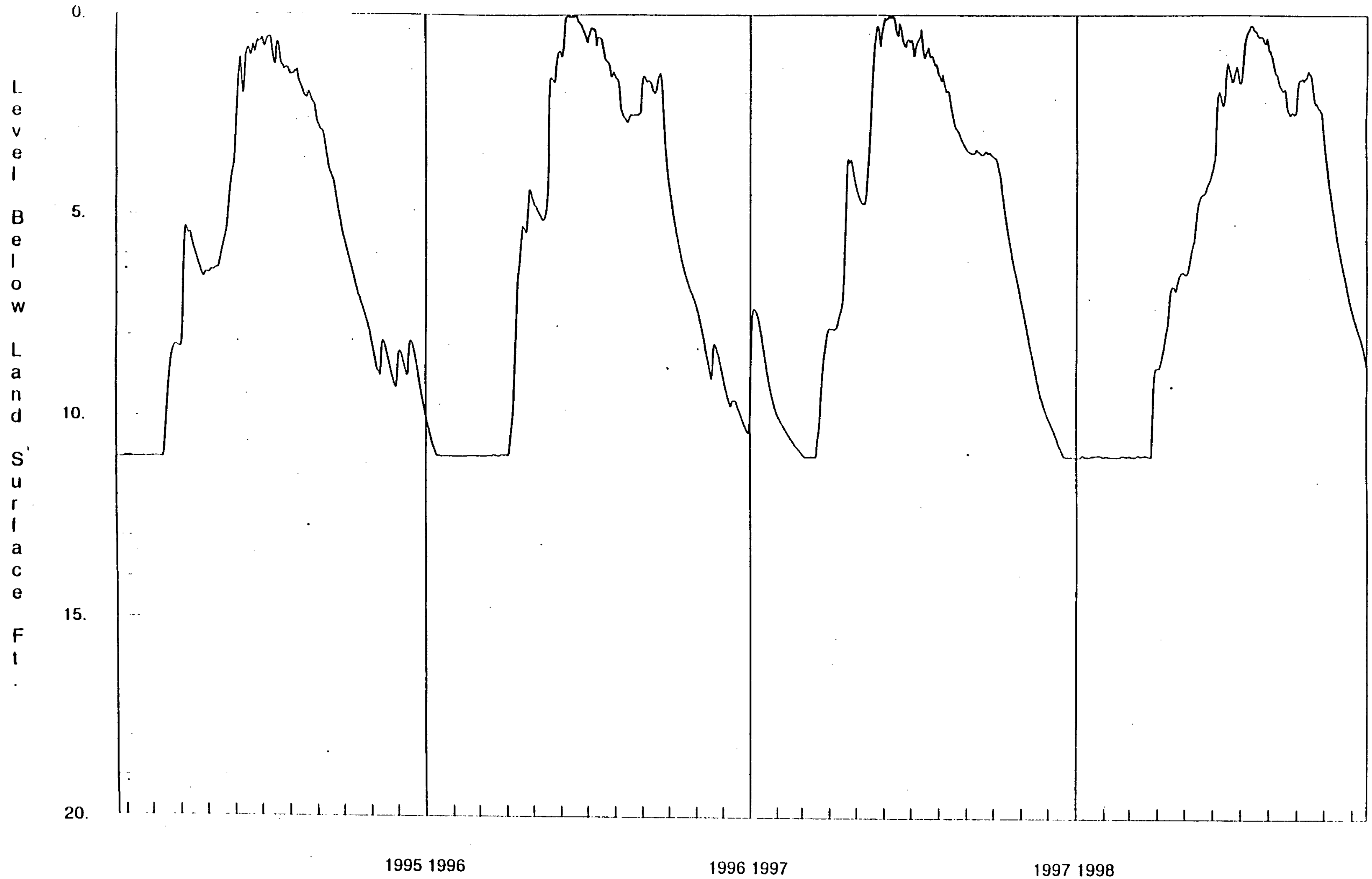
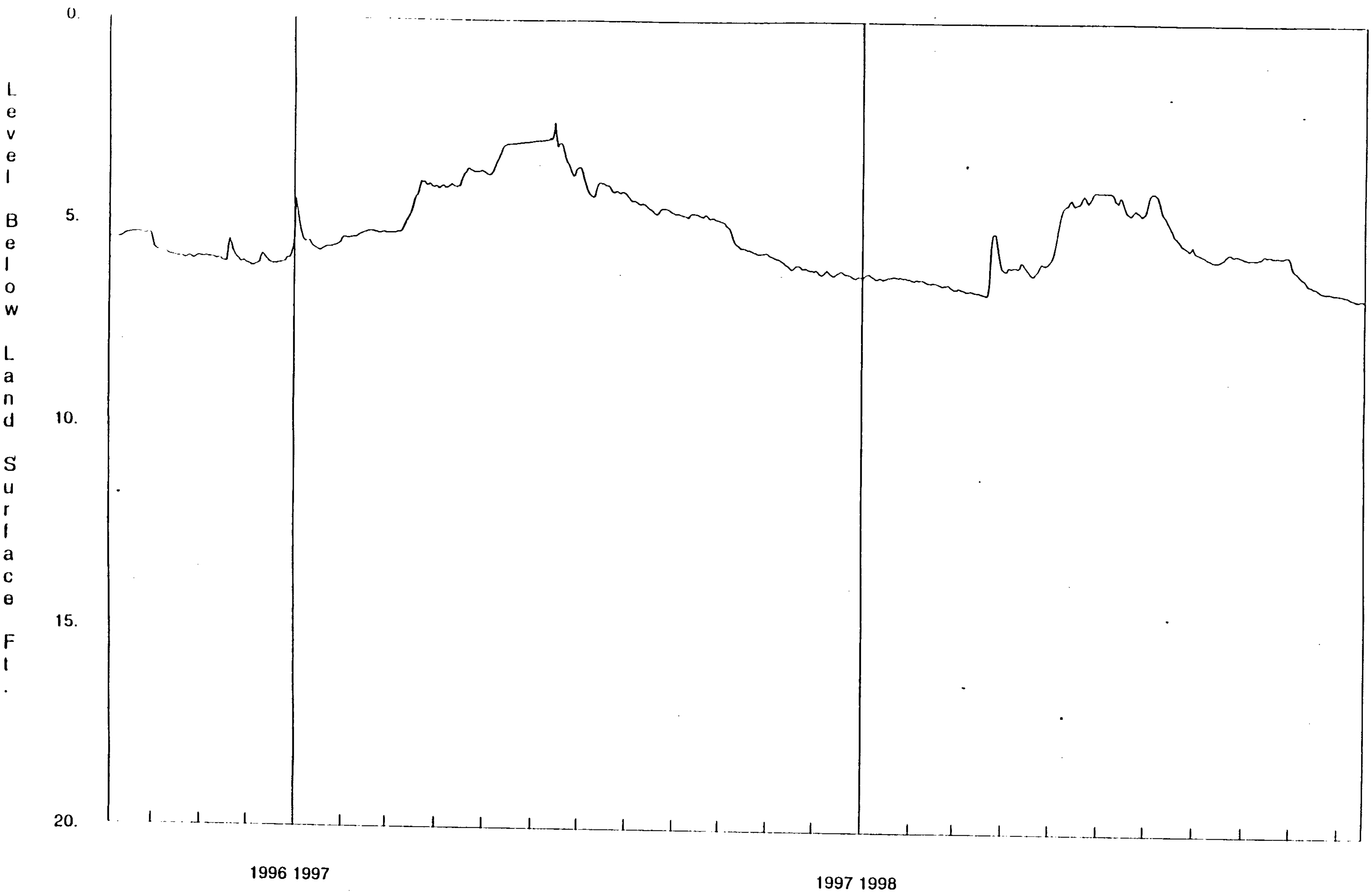


TCTC-6

Lege Recorded Data

Prepared by the Wyoming Sta ngineer's
Office in Cooperation with on County

42 116 29dbc Teto nty 4 15110471900



Legend: Recorded Data ———

TCTC-7

Prepared by the Wyoming State Engineer's
Office in Cooperation with T 1 County

42 116 20aab

Teton County

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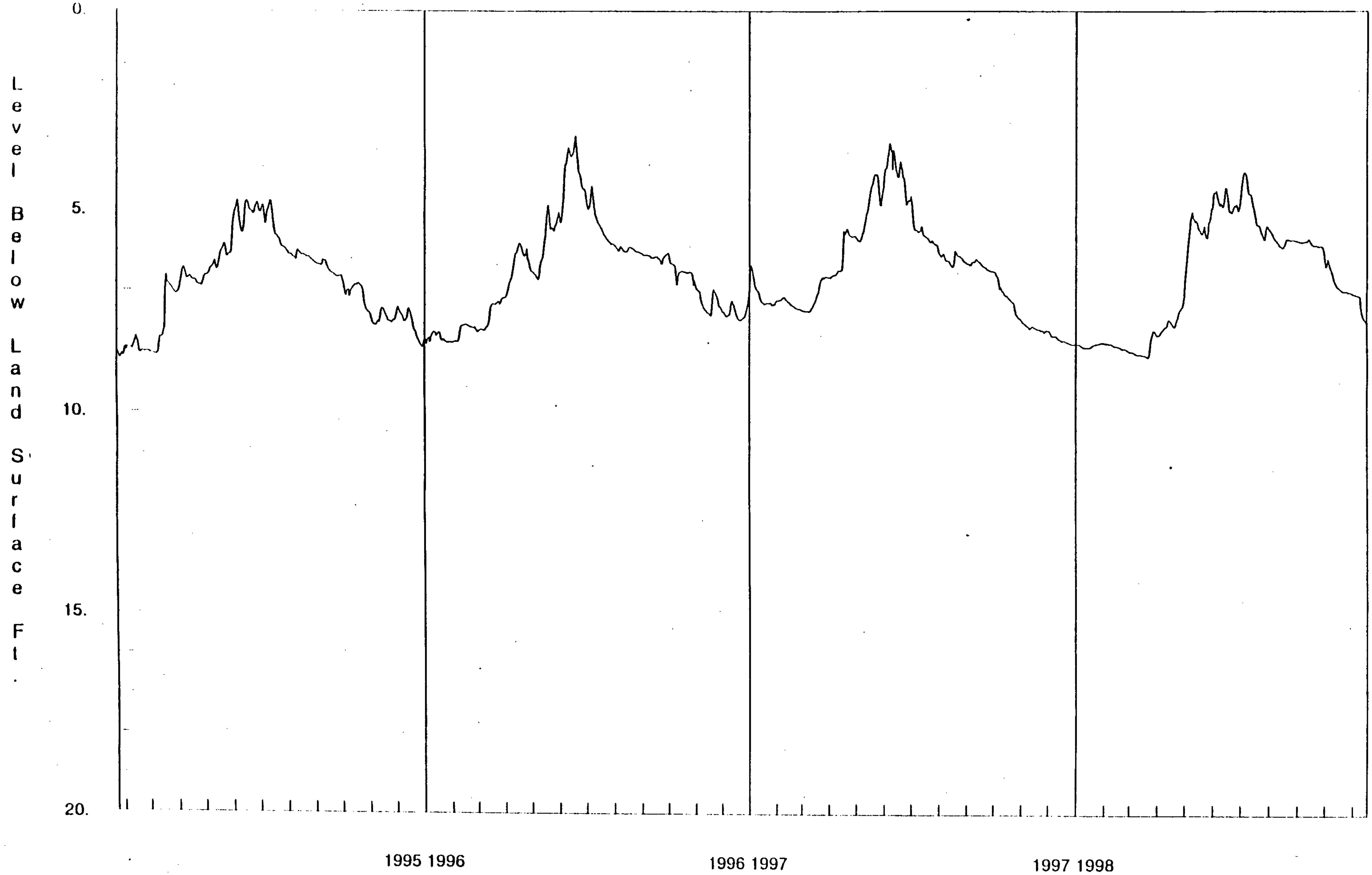


TCTD-1

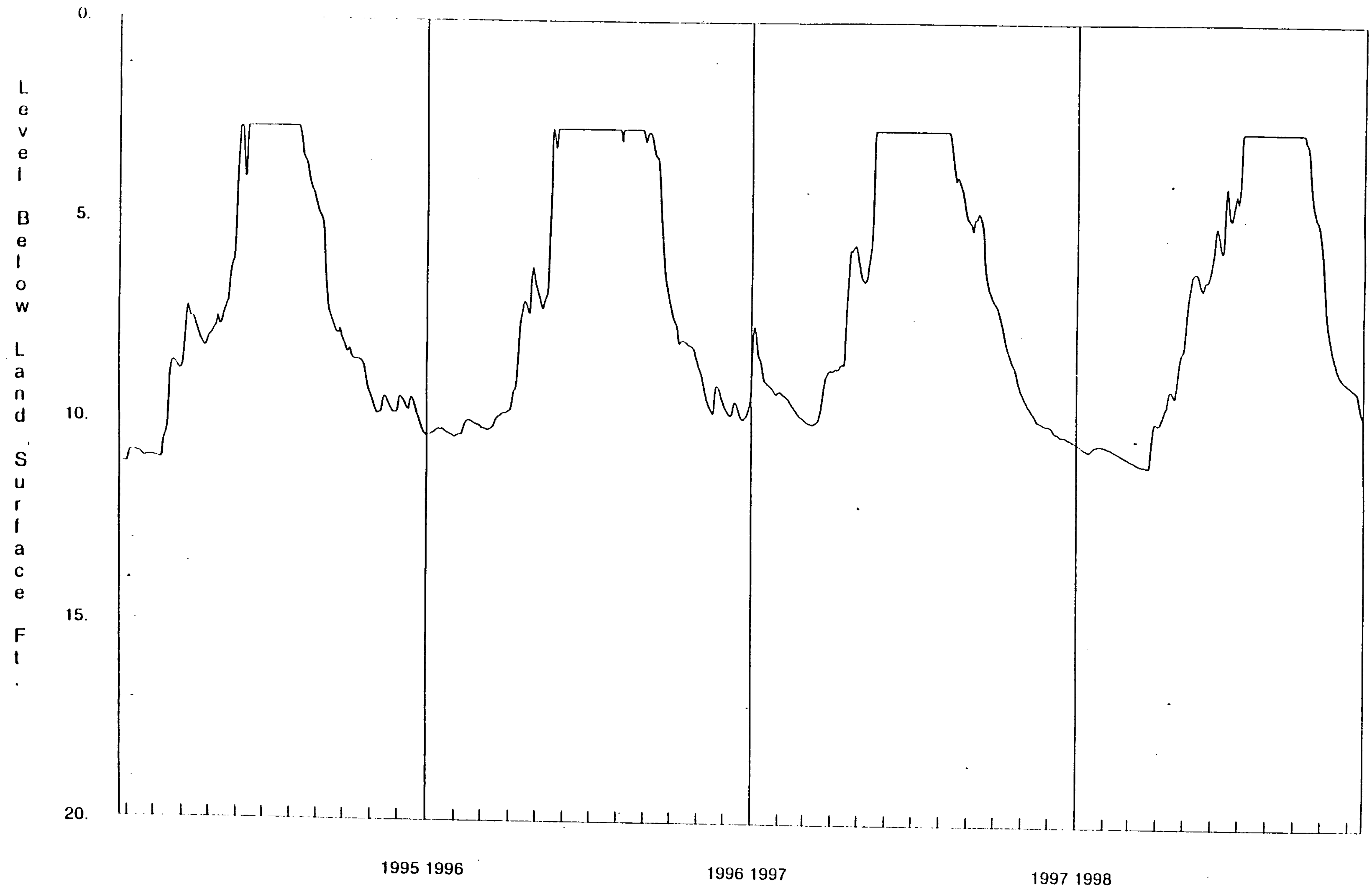
Lege Recorded Data

Prepared by the Wyoming St ngineer's
Office in Cooperation with on County

42 116-20bab

Teto[illegible]nty

43[illegible]46110474800



Legend: Recorded Data

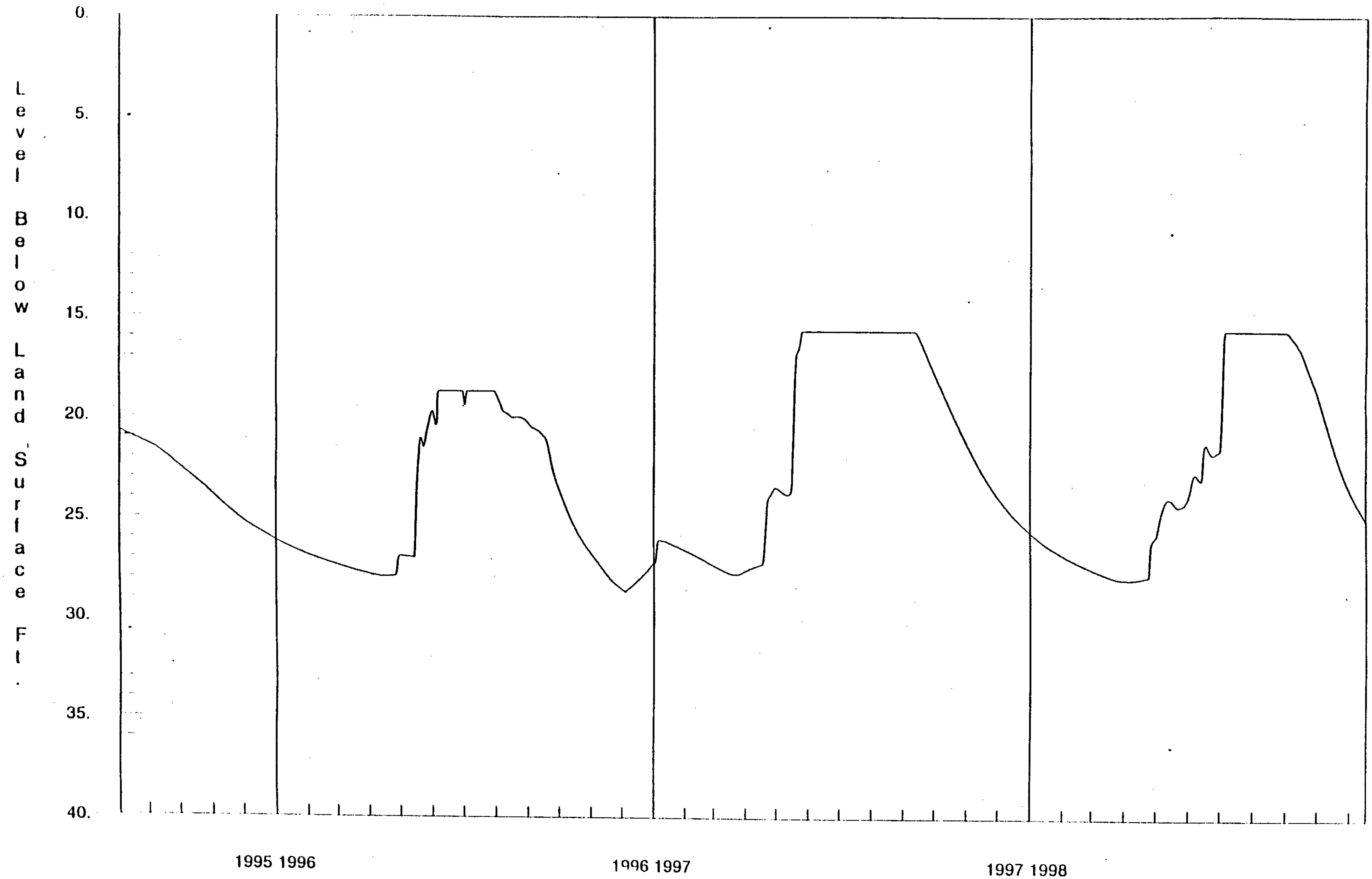
TCTD-2

Prepared by the Wyoming Stat[illegible] Engineer's Office in Cooperation with [illegible]n County

Teton County

42 116-19aaa

433545110481200



TCTD-3

Leg Recorded Data ———

Prepared by the Wyoming Sta ngineer's Office in Cooperation with T n County

42 116 20dcc

Teto inty

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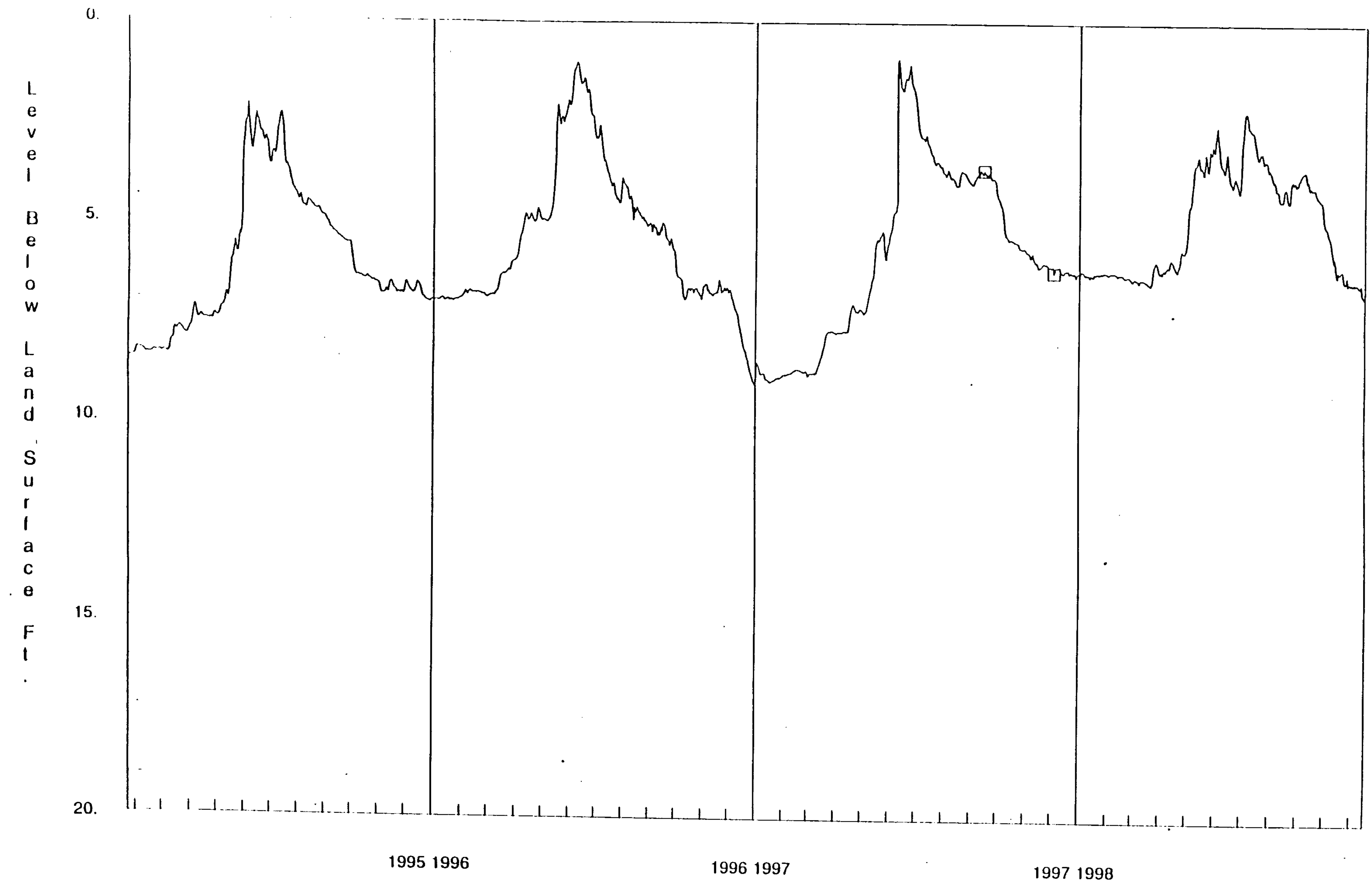

Legend: Recorded Data ———— Hand Measurement □

TCTD-5

Pre, ed by the Wyoming State Engineer's Office in Co ration

Teton County

42 116 29cdc

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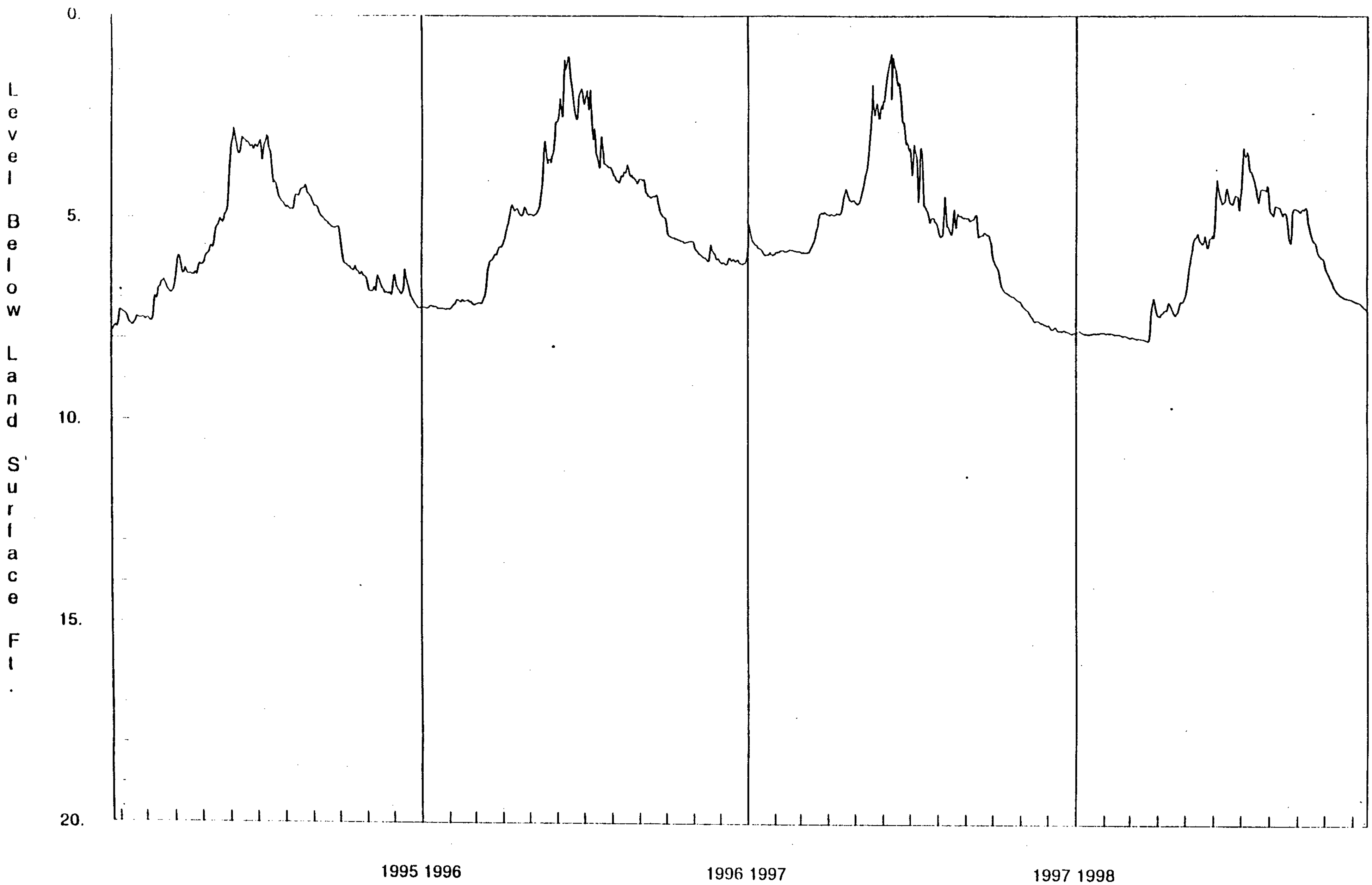
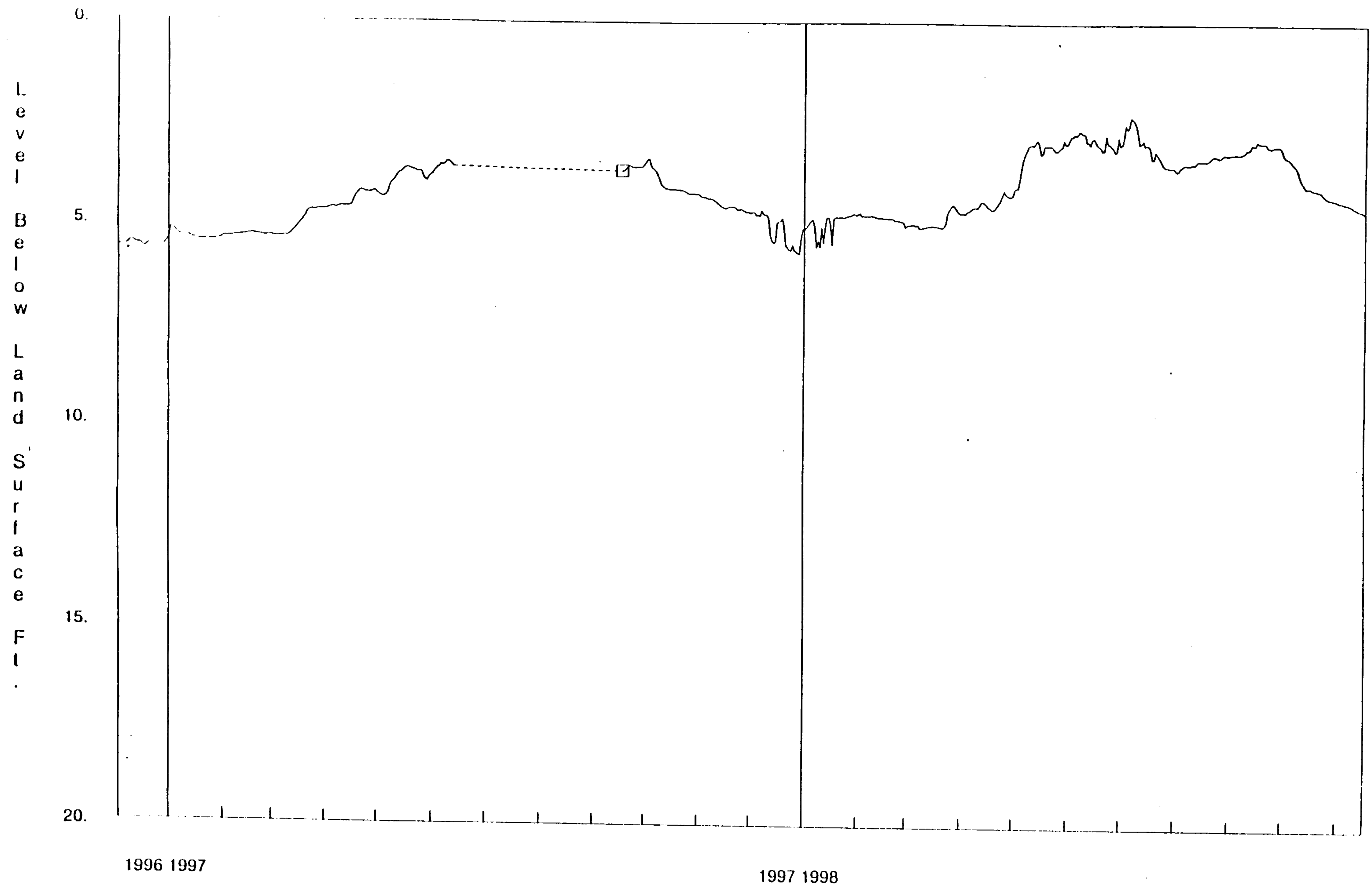


TCTD-6

Lege ecorded Data ——— ---

Prepared by the Wyoming Sta gineer's Office in Cooperation with n County

42 116 21bba   Teton ..ty   43 7110464000



Legend: Recorded Data ———— Missing Daily Value ········
Hand Measurement □

TCTD-7

Teton County

41 117 26bcc

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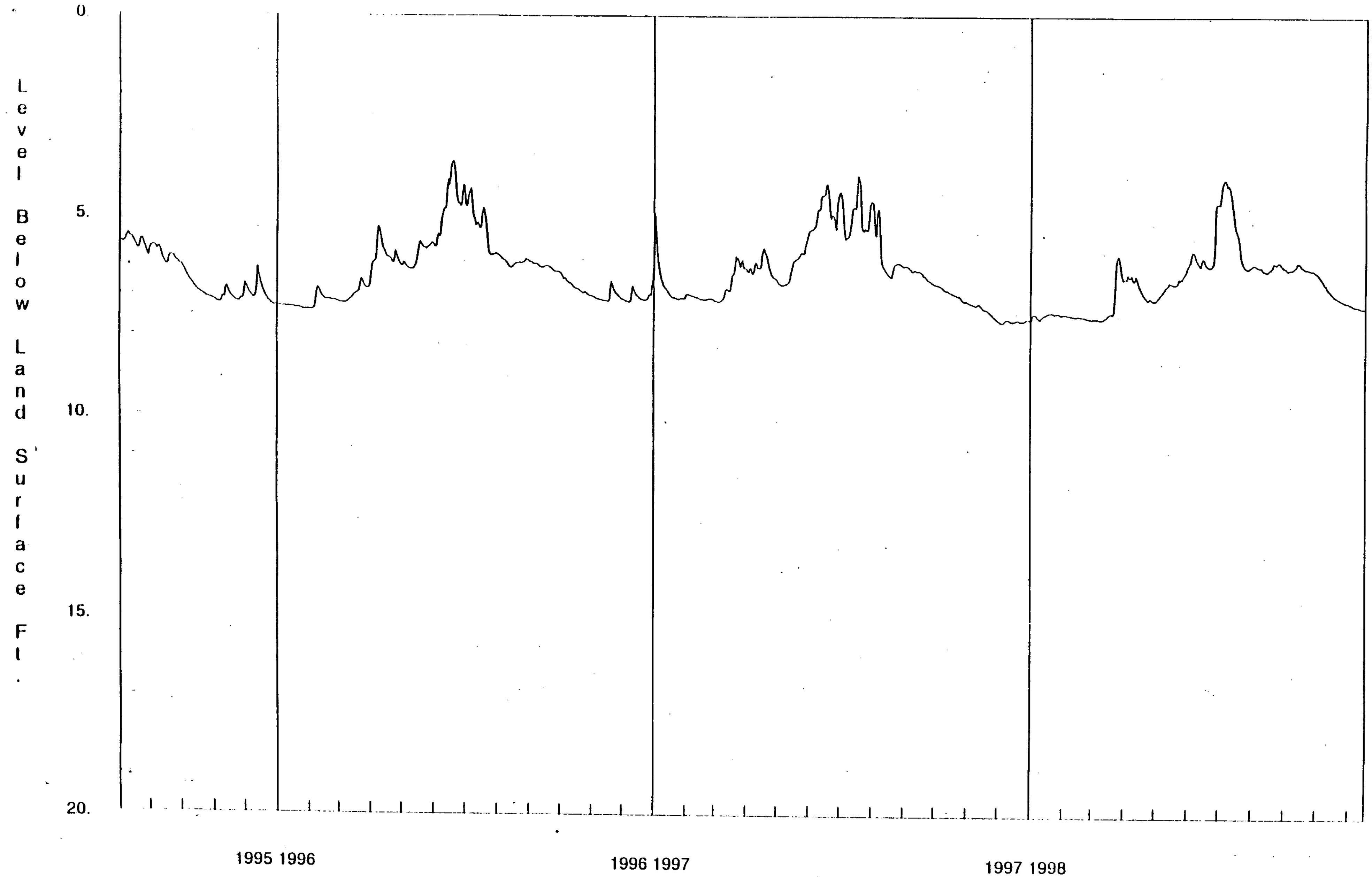
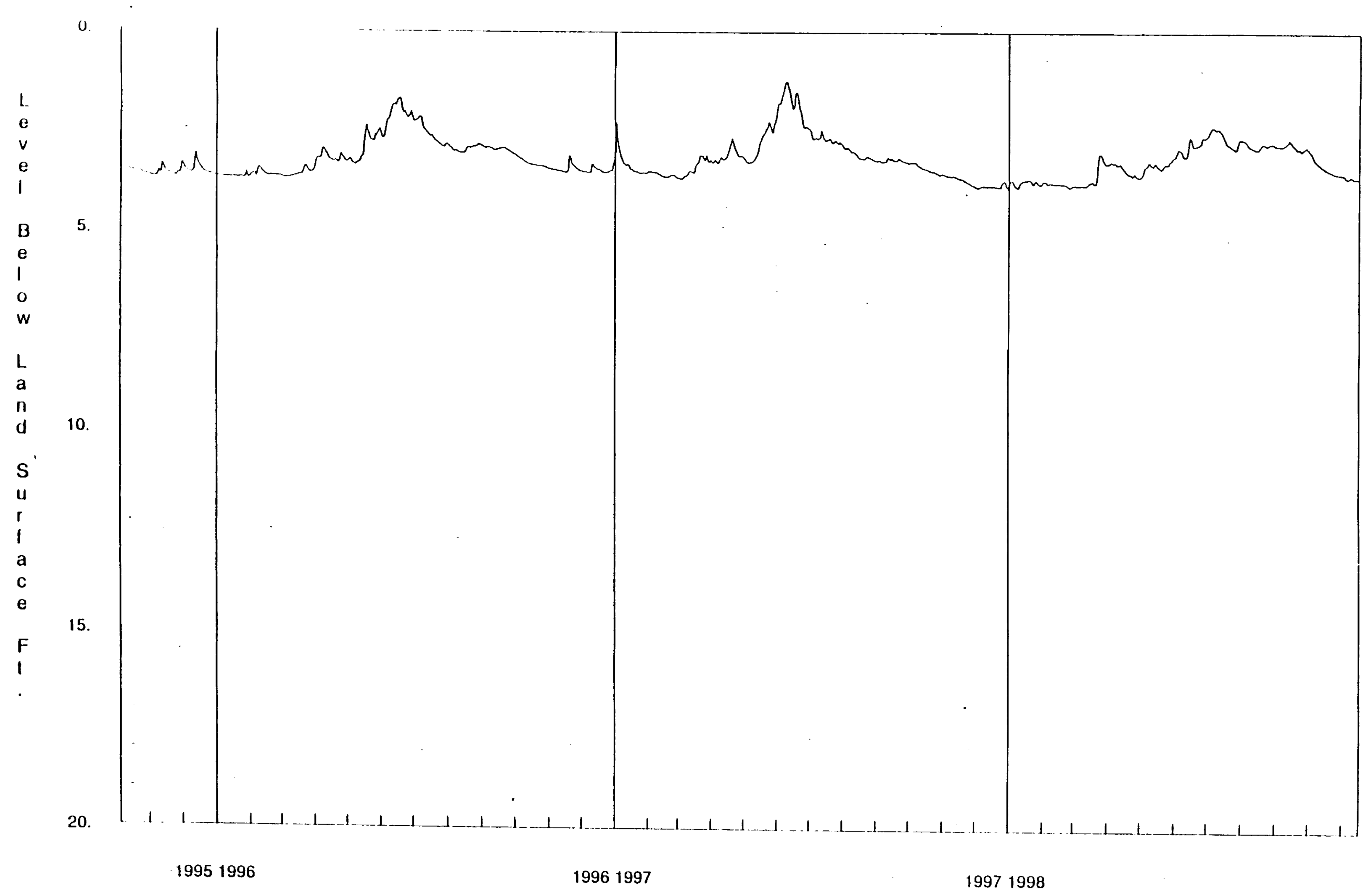


TCTE-1

Leger ecorded Data ———

Prepared by the Wyoming Stat gineer's
Office in Cooperation with T ı County

11 117 22cda Teton County 432 6110521800



TCTE-2

Prepared by the Wyoming State Engineer's Office in Cooperation with Teton County

Teton County

41 117 01add

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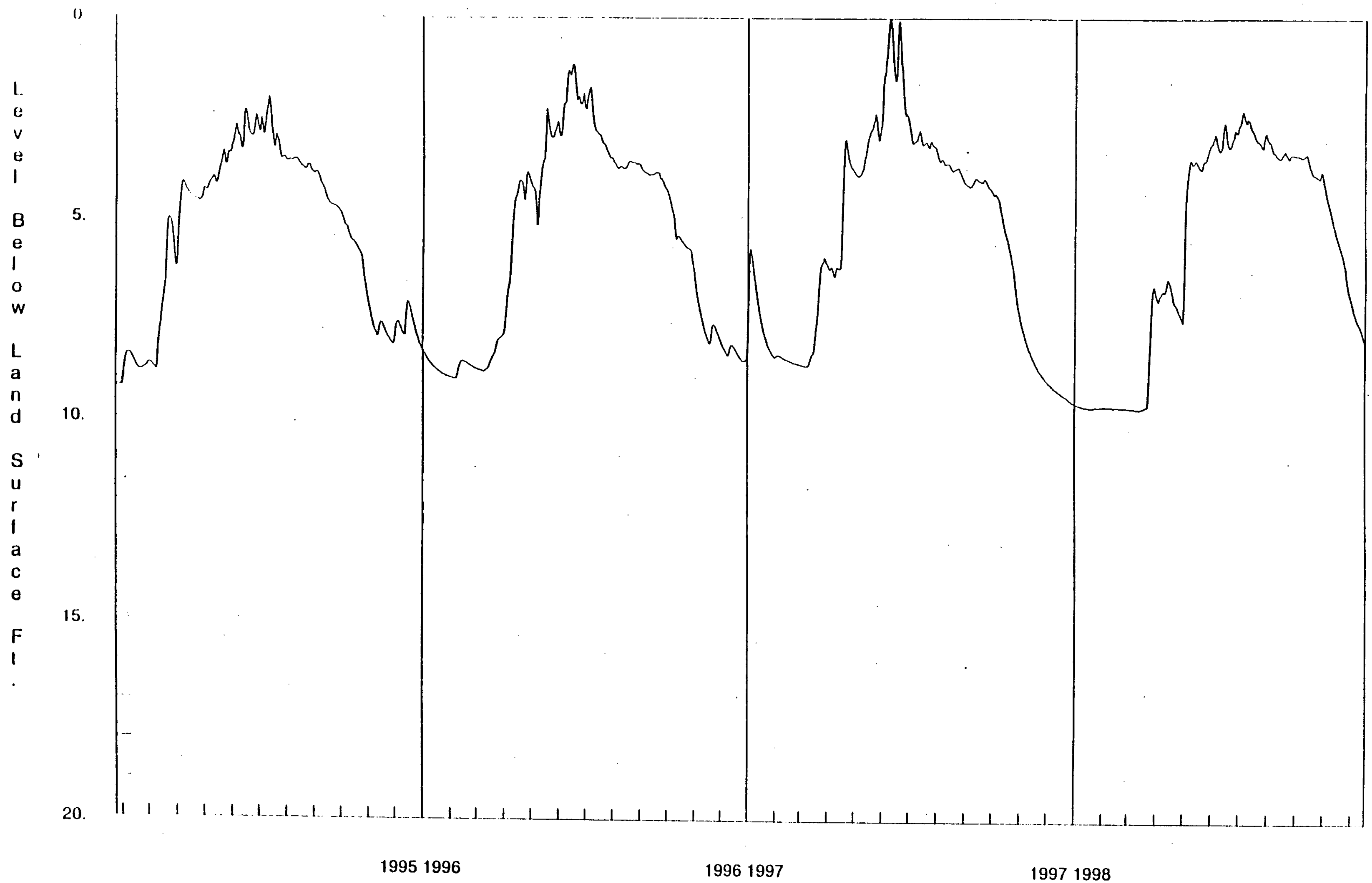
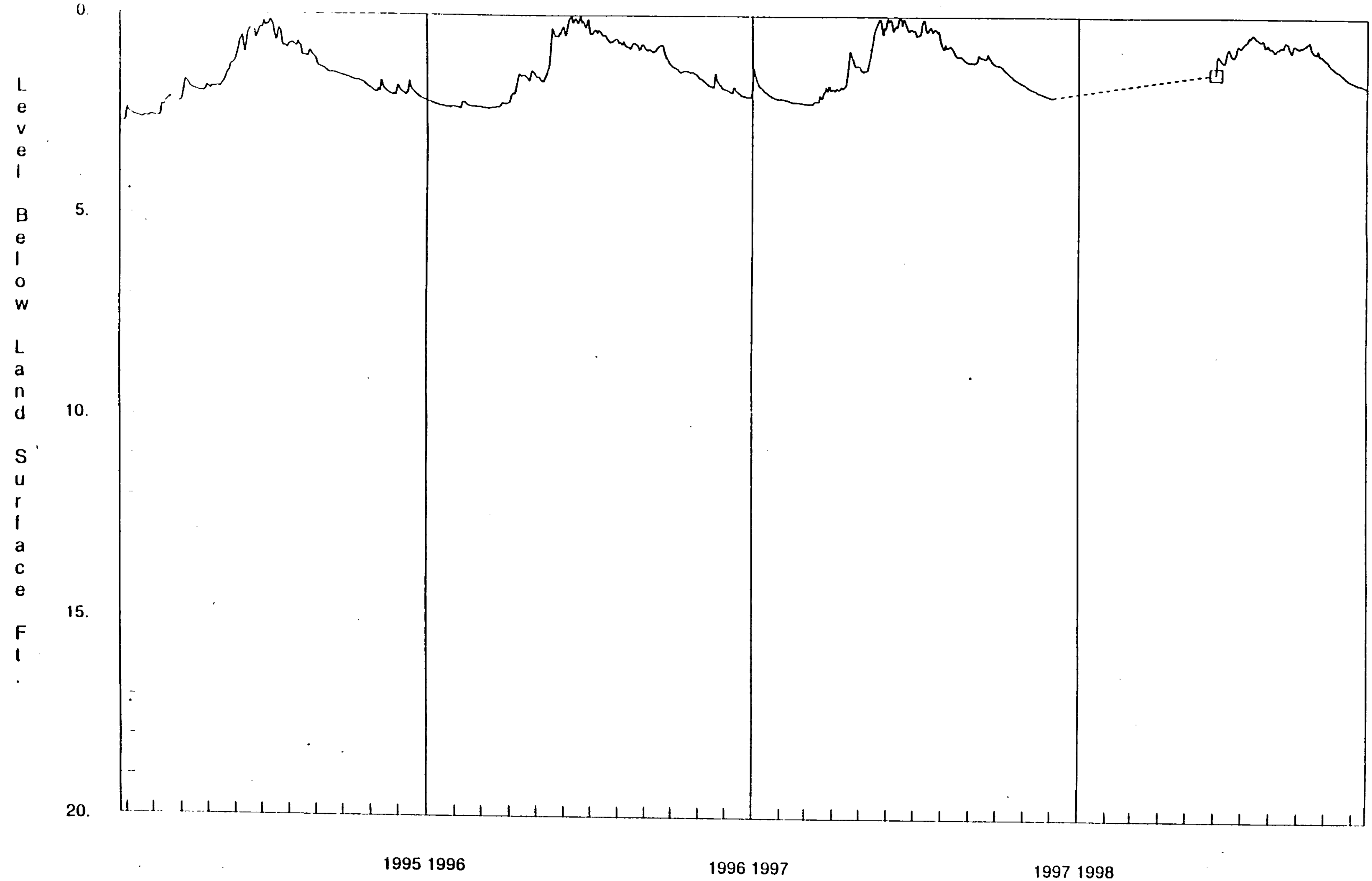


CTR-1

Legen ecorded Data ———

Prepared by the Wyoming Stat gineer's
Office in Cooperation with Te County

11 117 02daa Teton ıty 43 0110503500



Legend: Recorded Data ——— Missing Daily Value ---------
land Measurement □

TCTR-2

PART V. GROUND WATER DATA

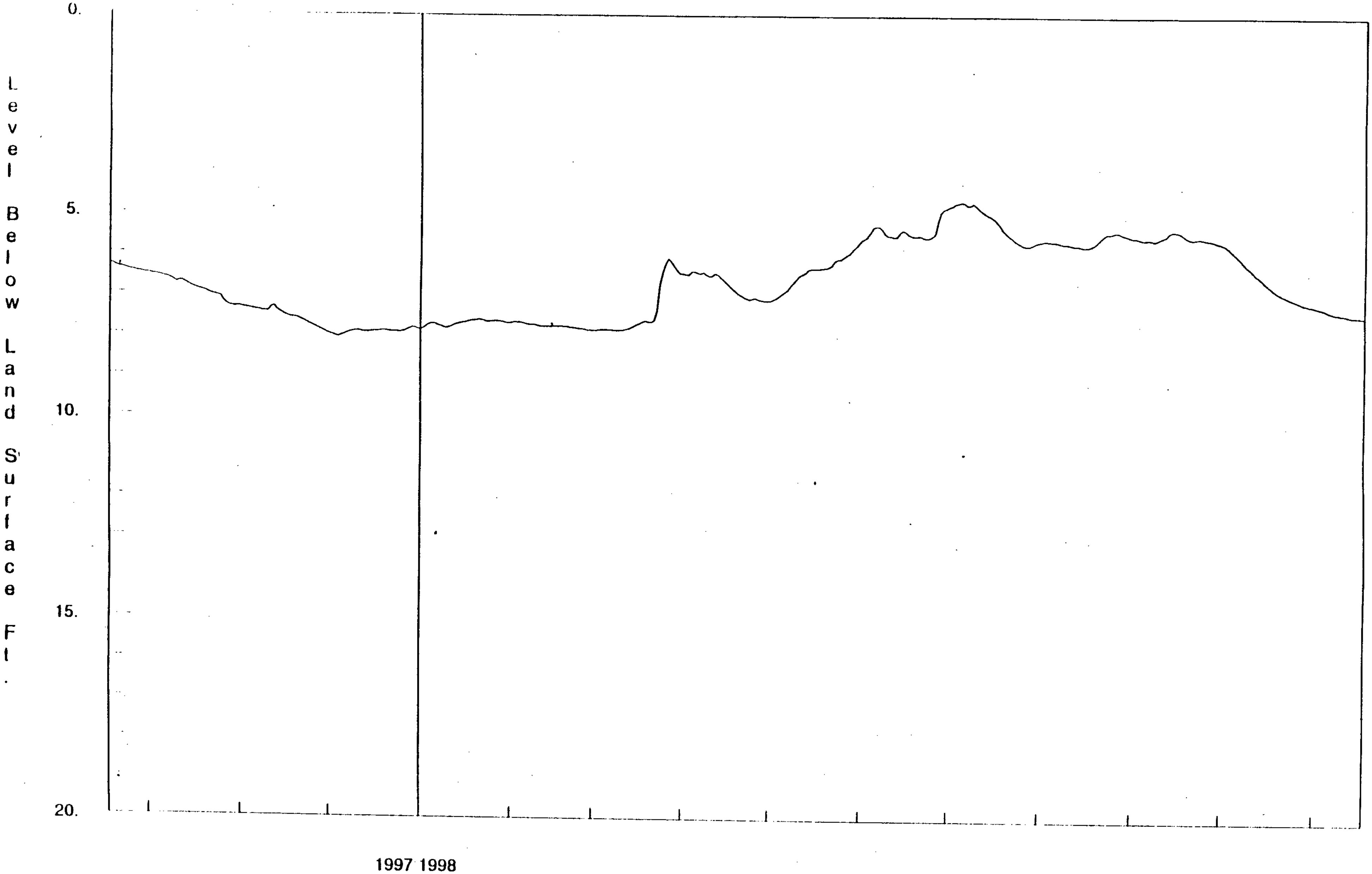
b) JHERS Observation Well Hydrographs

1. TC 1 through TC 15

Teton County

41 117-23cdd

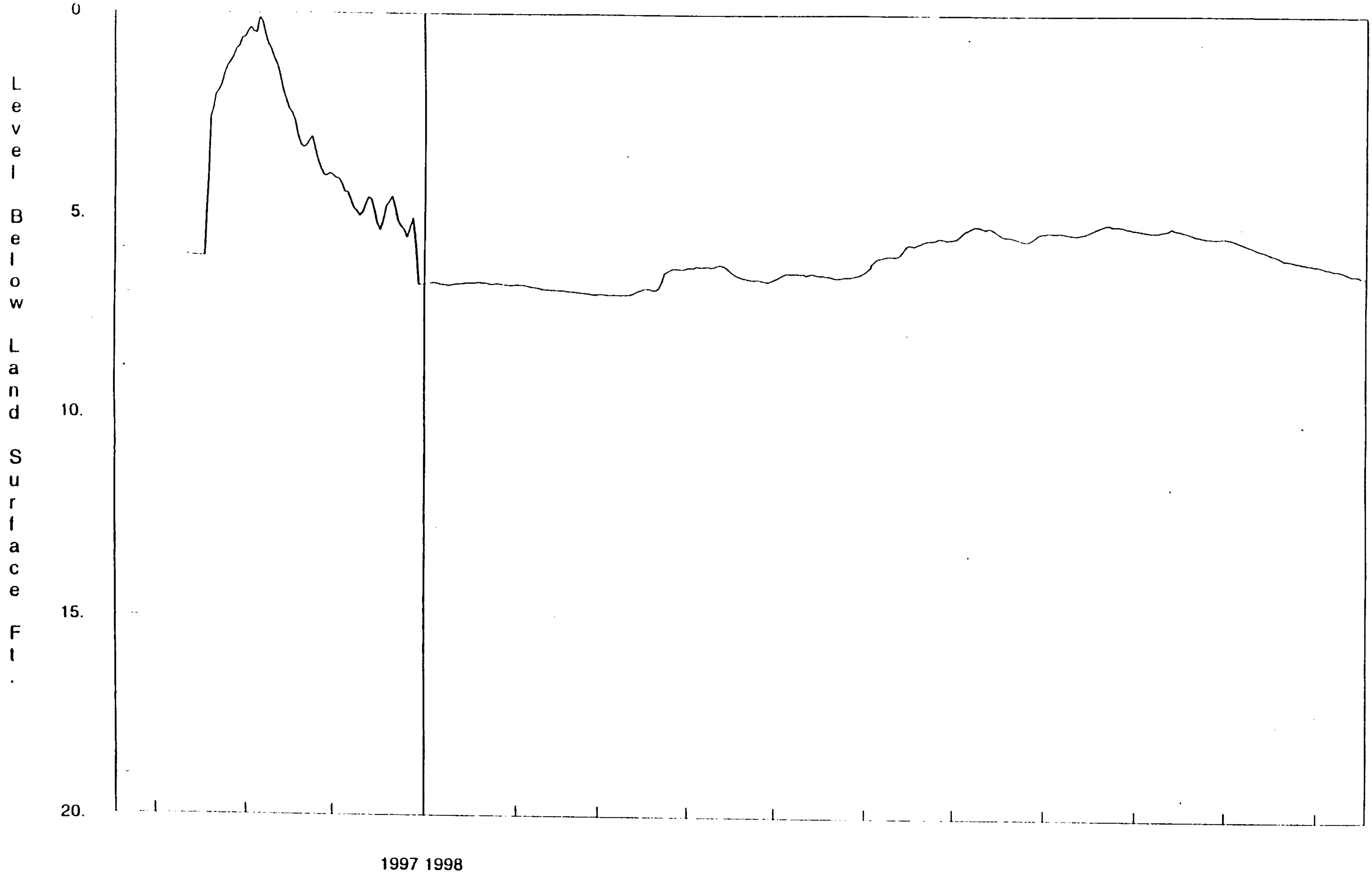
432944110510900



TC-1

Lege Recorded Data

Prepared by the Wyoming Sta ngineer's
Office in Cooperation with n County



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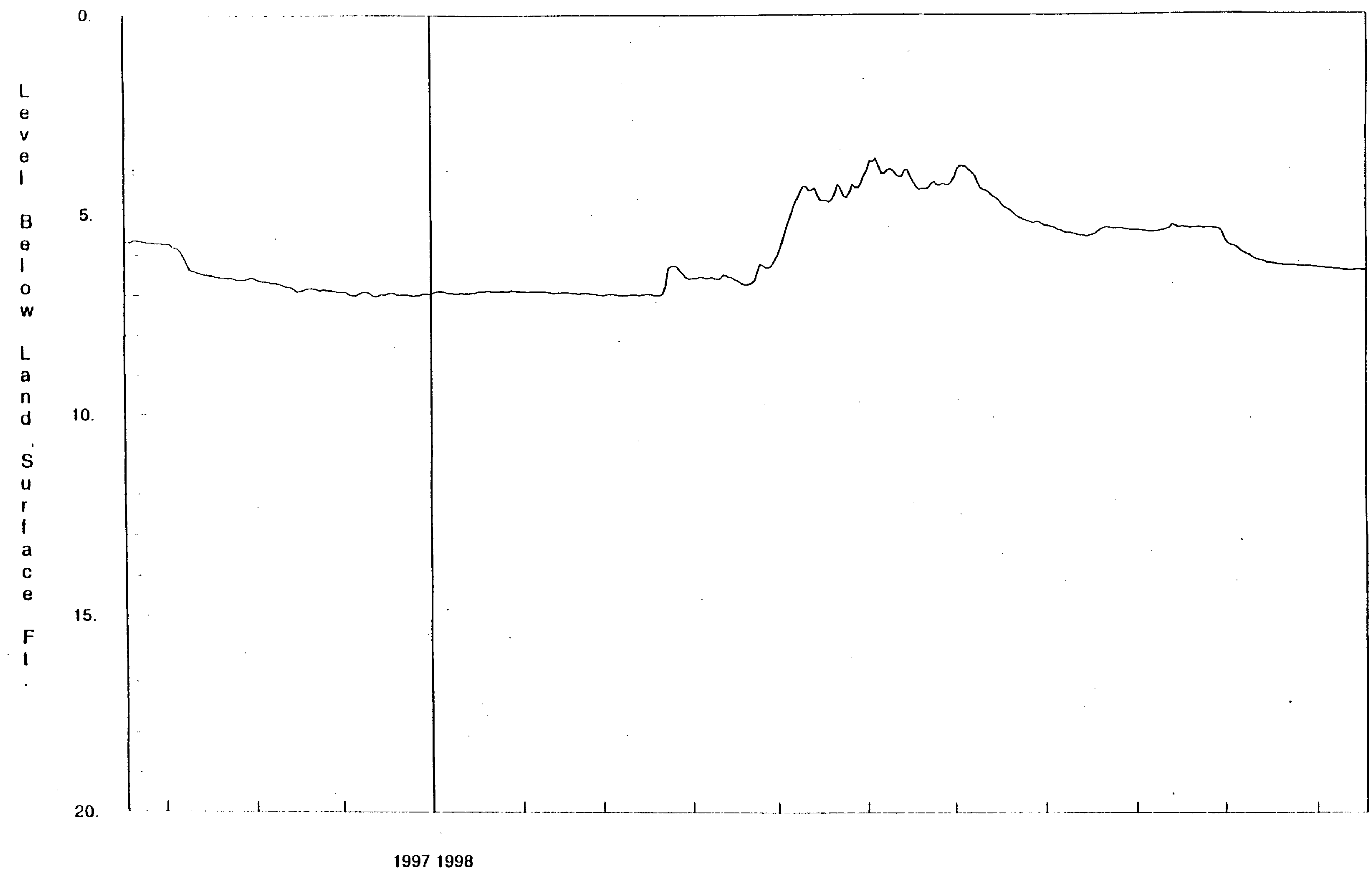
Prepared by the Wyoming State Engineer's Office in Cooperation with T on County
February, 1999

41-117-26cad

Teton County

432904110510800



Legend: Recorded Data ———

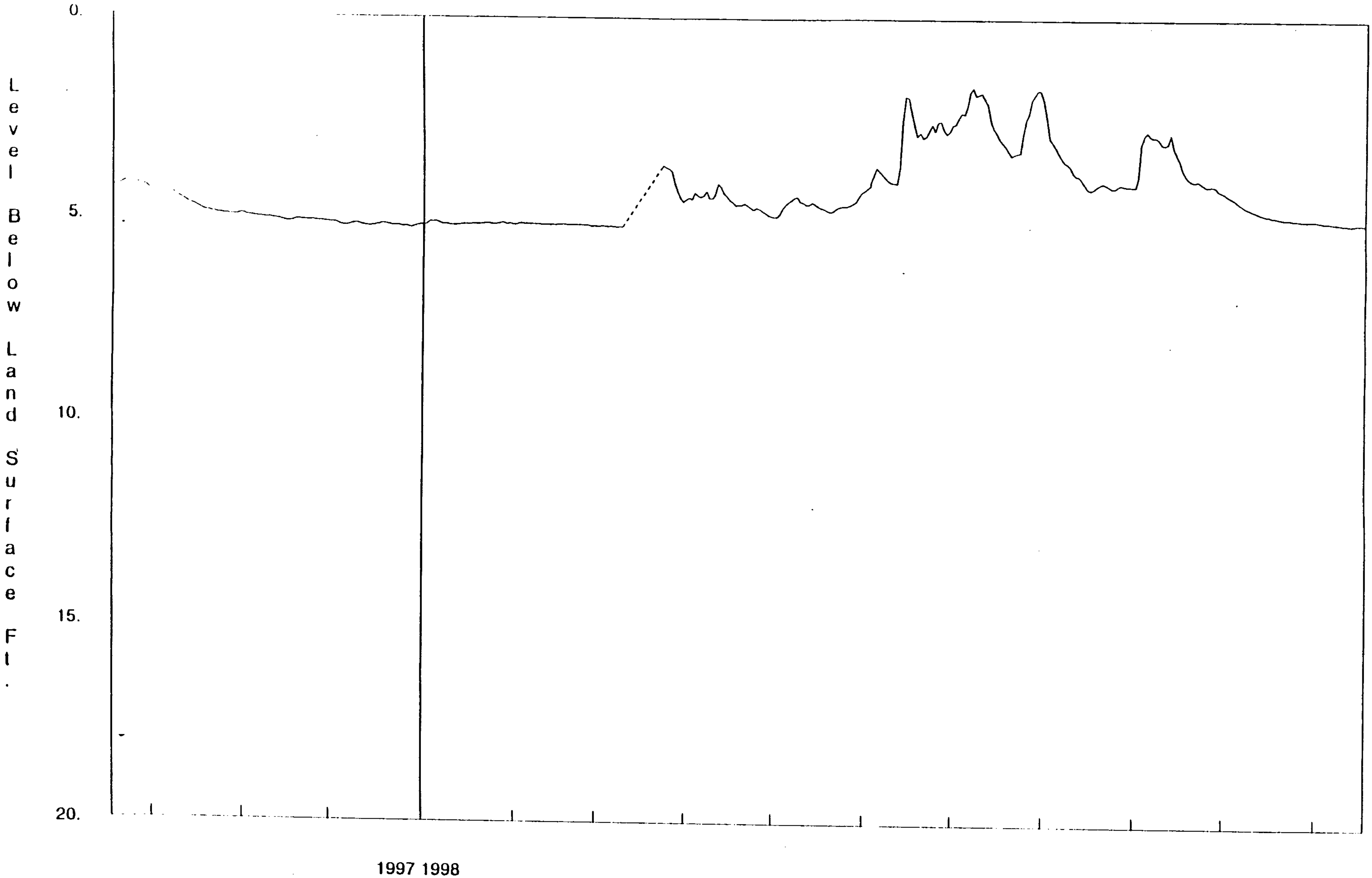
Prepared by the Wyoming Sta[illegible] ngineer's
Office in Cooperation with [illegible] a County

TC-3

41 117-27cbc

Teton nty

43 02110523500



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TC-4

Prep ed by the Wyoming State Engineer's Office in Coo ation

41 117 26ccd

Teton County

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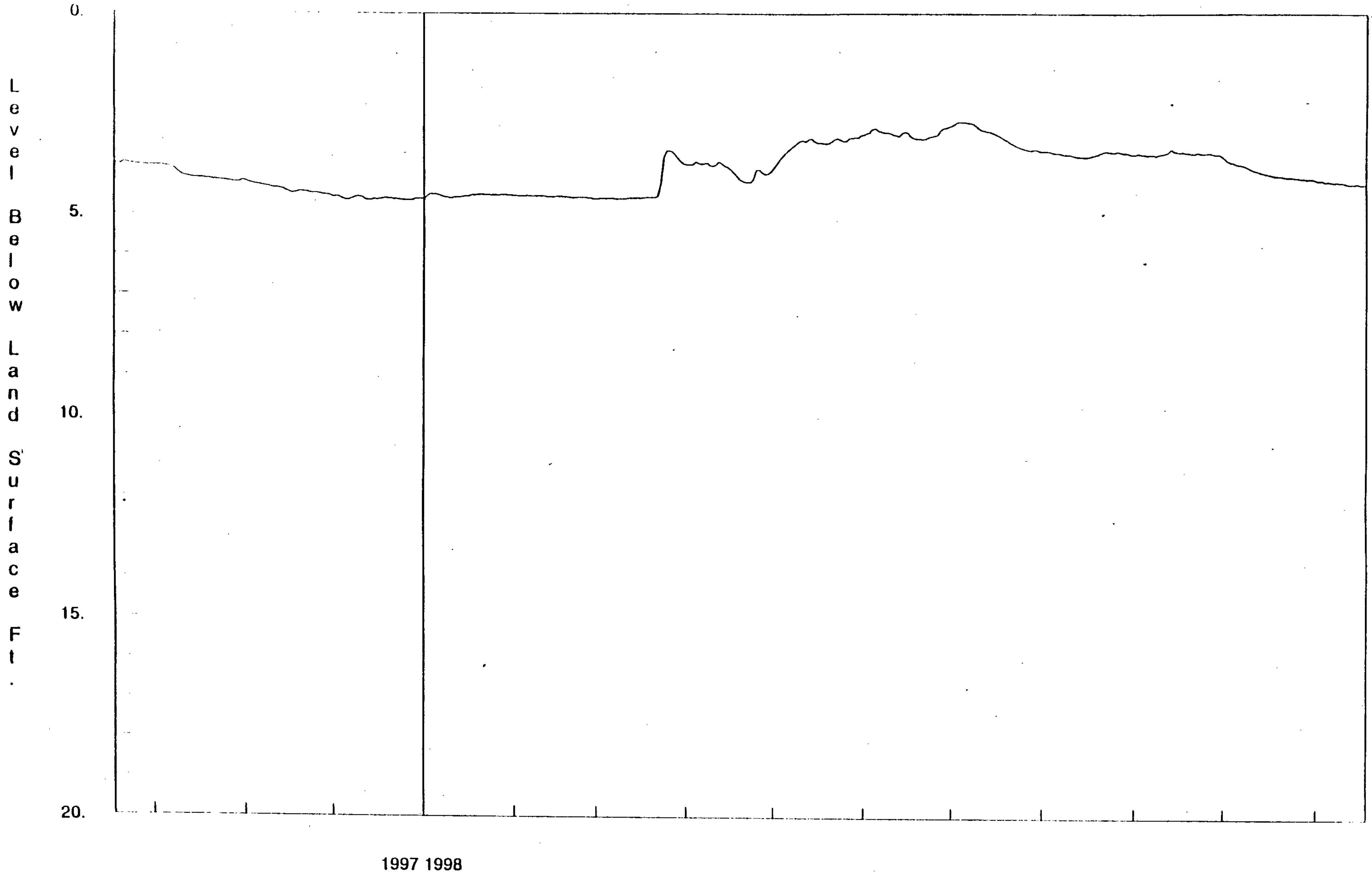

TC-5

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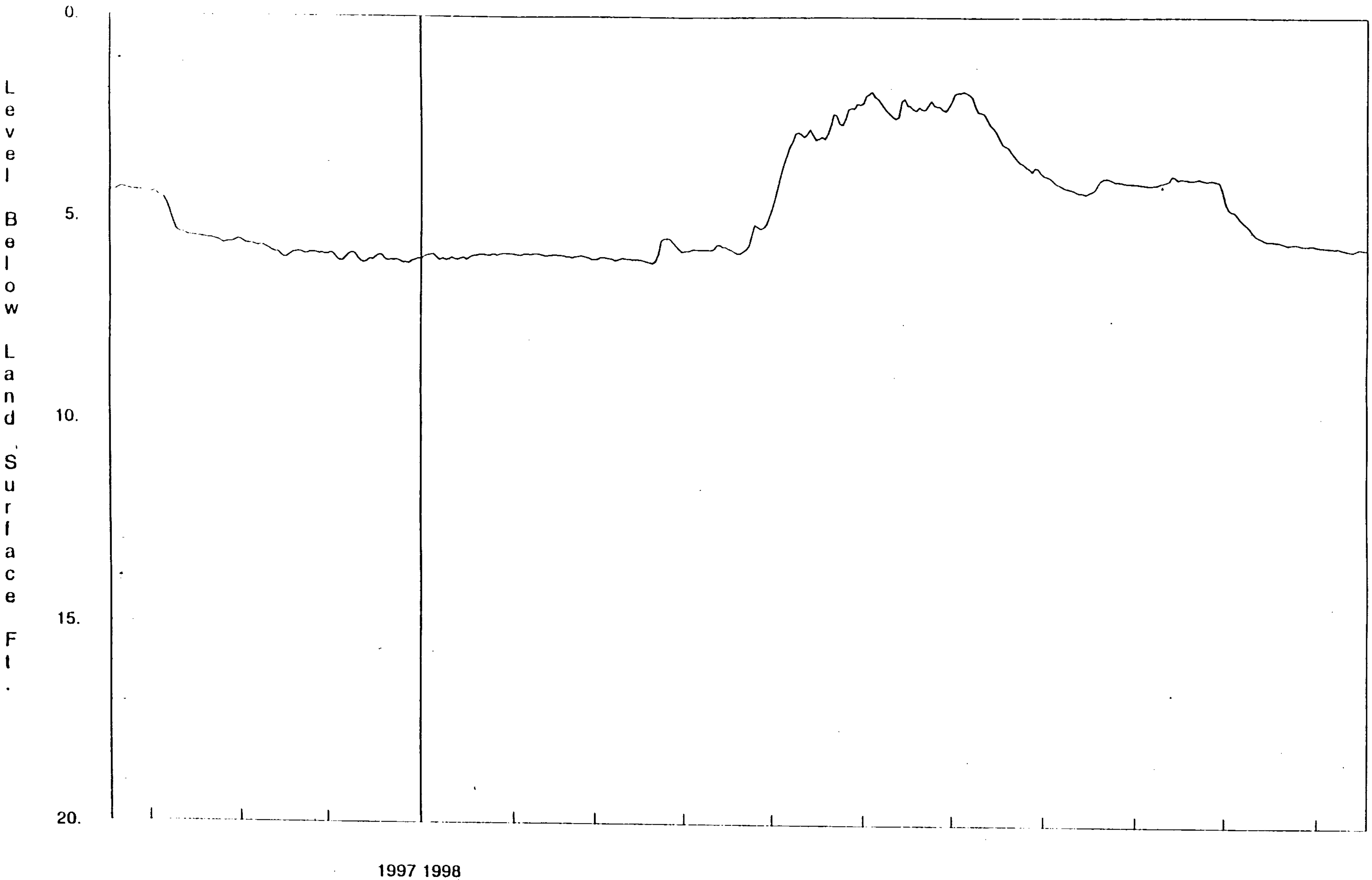
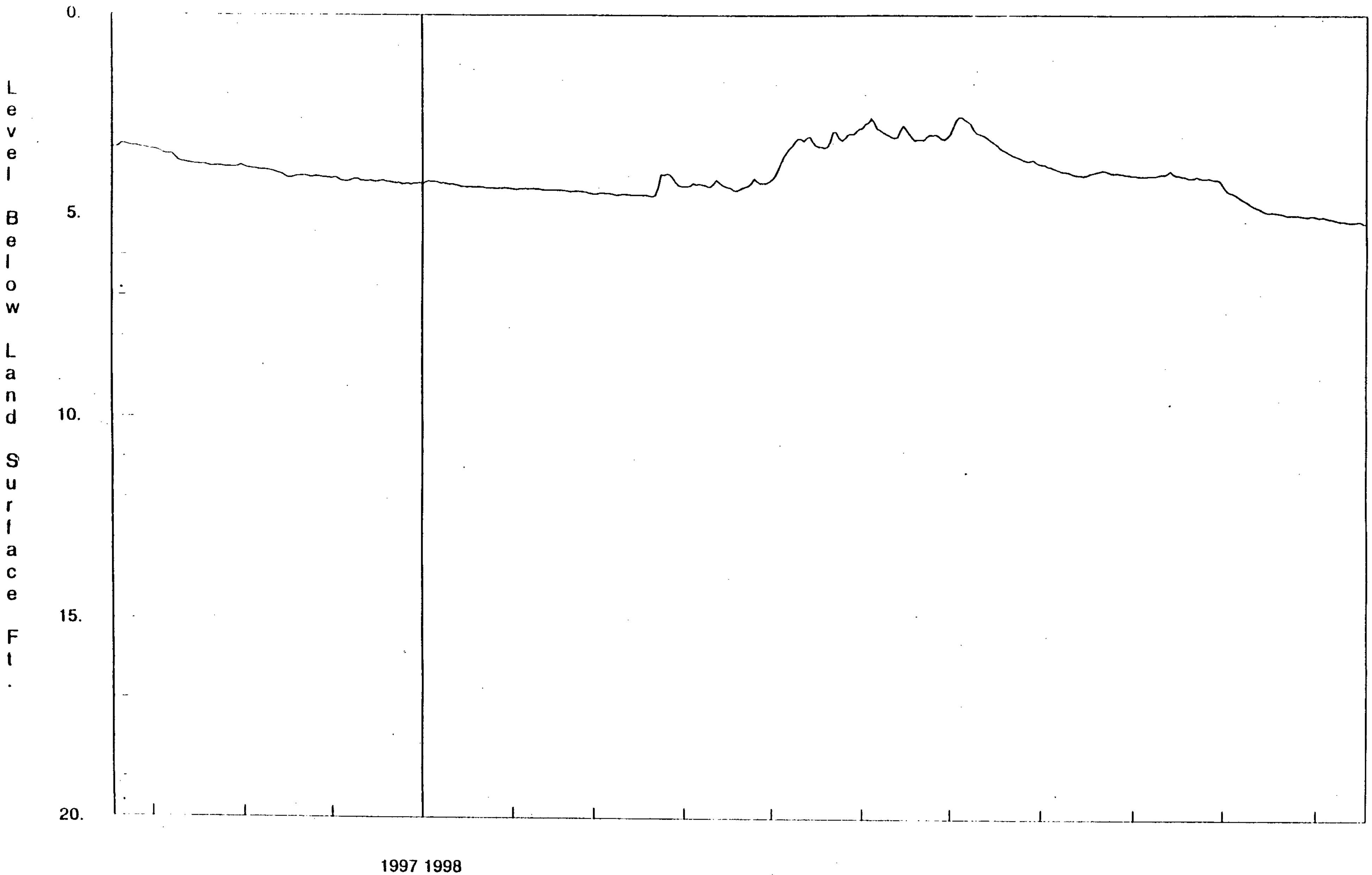
41-117-35ccd Teton nty 432 9110512600



Legend: Recorded Data ———— Prepared by the Wyoming State Engineer's Office in Cooperation with Te County

TC-6

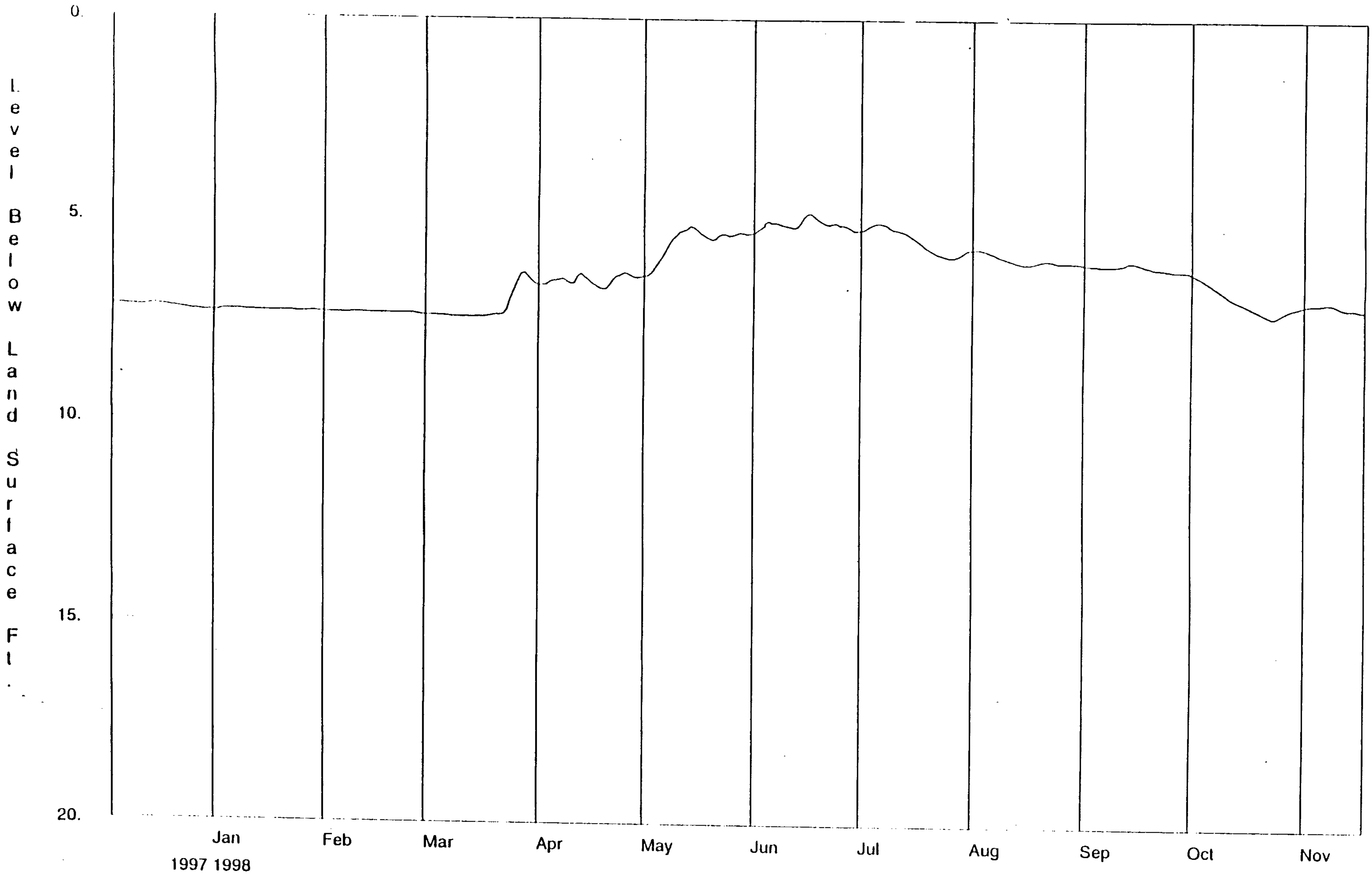
40 117-3dcc Teton County 432706110513400



TC-7

Leg Recorded Data ——— Prepared by the Wyoming State gineer's Office in Cooperation with T County February 1999

40 117 10cab Teto unty 4 34110513400



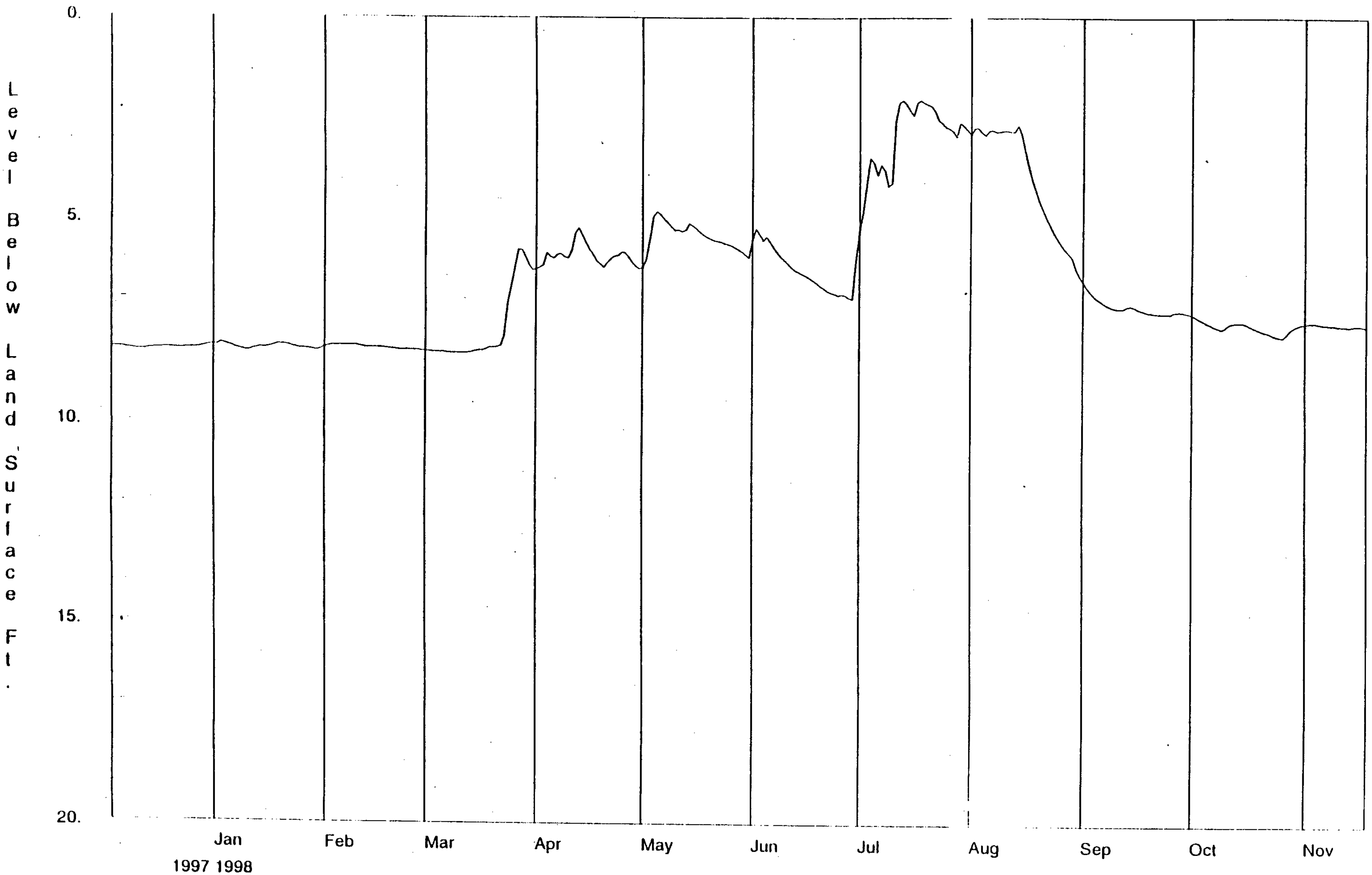
Legend: Recorded Data ———— Prepared by the Wyoming State Engineer's Office in Cooperation with Te County

TC-8

40 117 14cdc

Teton County

432518110504100



TC-9

Leg Recorded Data

Prepared by the Wyoming Sta ngineer's
Office in Cooperation with T on County

40 117-25bac

Teto[...]unty

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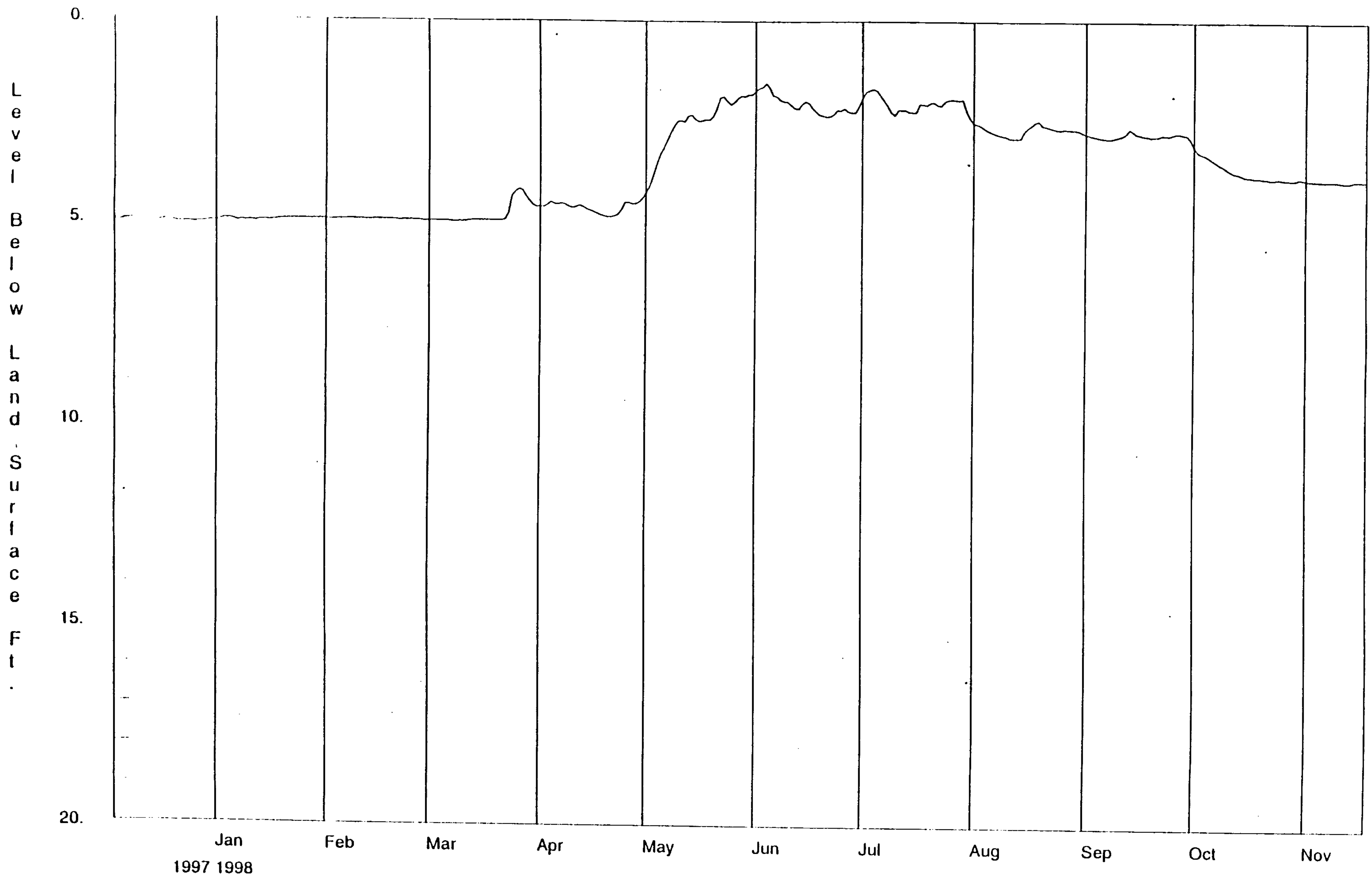

Legend: Recorded Data ———

Prepared by the Wyoming State Engineer's Office in Cooperation with T n County

TC-10

41 117-24cca

Teton County

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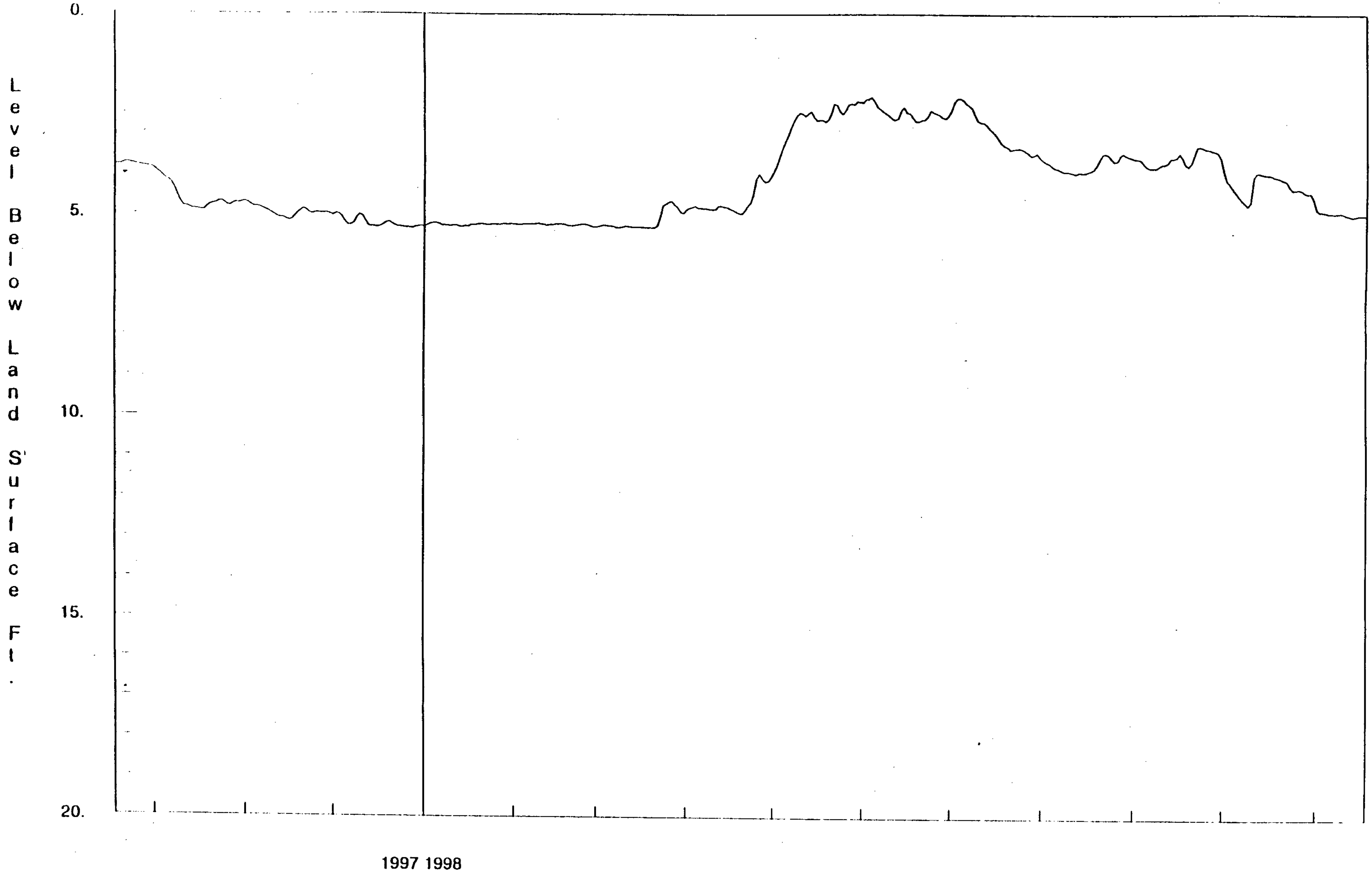


TC-11

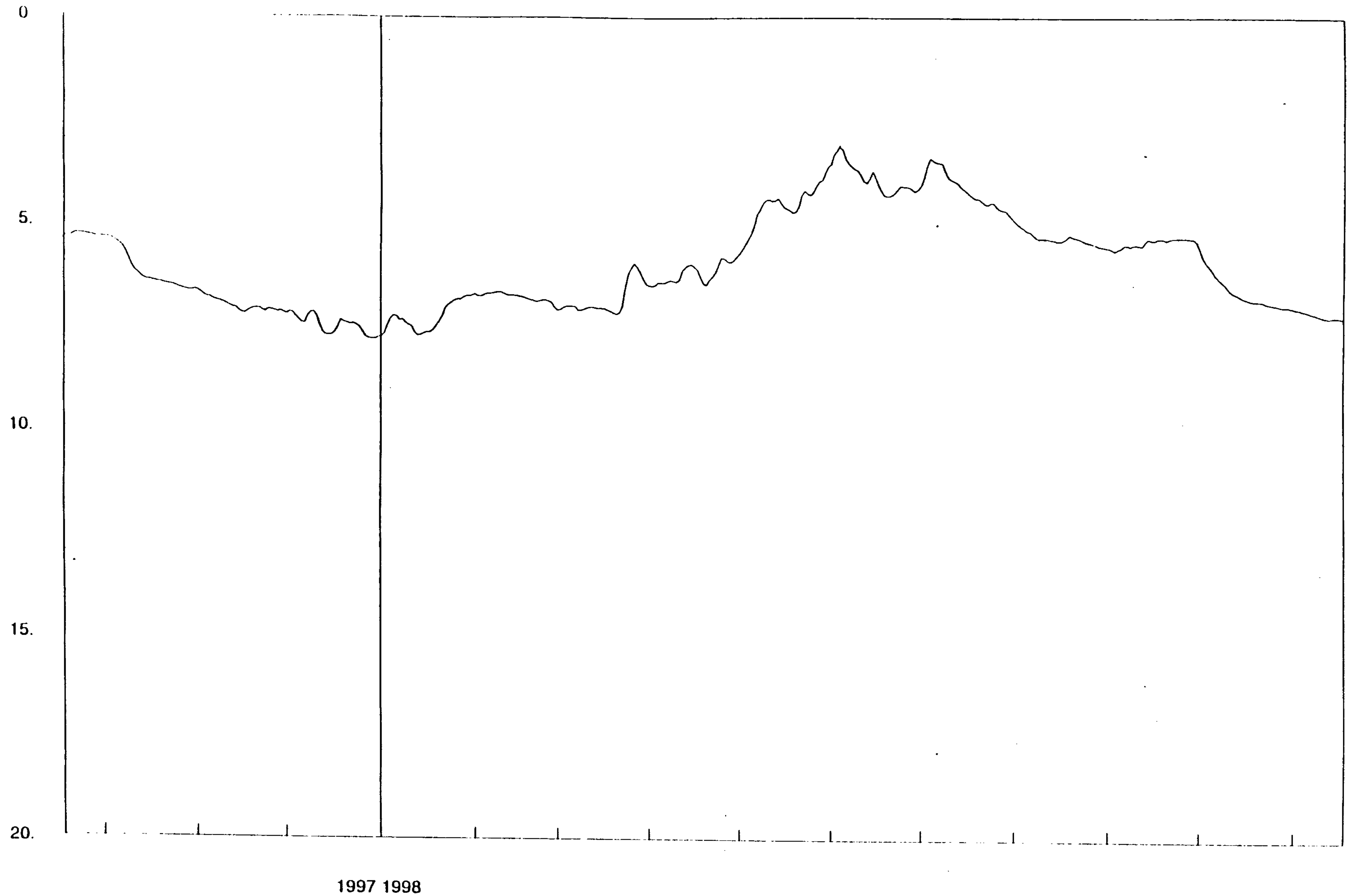
Lege Recorded Data

Prepared by the Wyoming Sta Engineer's
Office in Cooperation with on County
February, 1999

41 117 35dcb

Teton County

432804110510000



Prepared by the Wyoming State Engineer's Office in Cooperation with T n County

TC-12

Teton County

40 117-3cca

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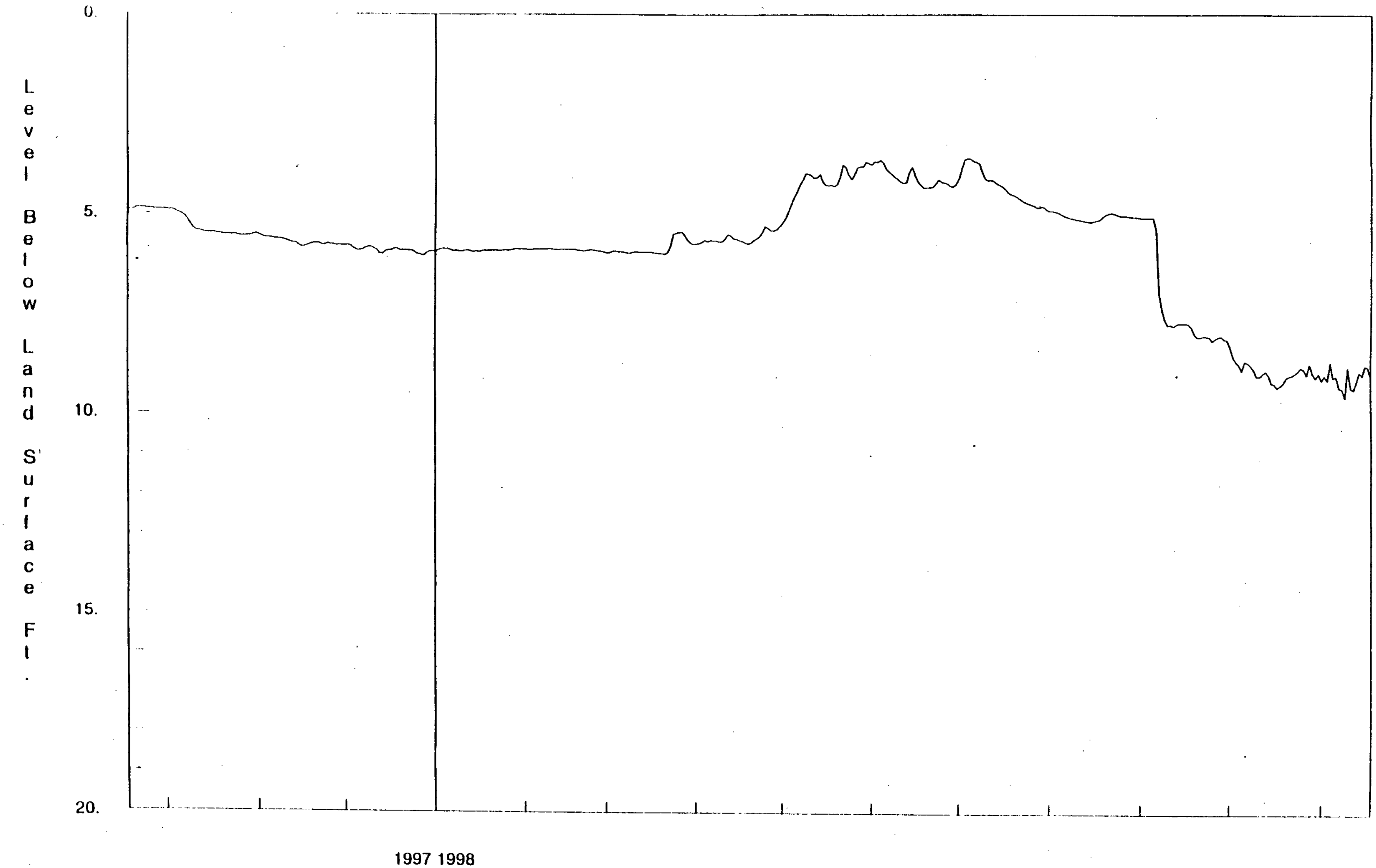
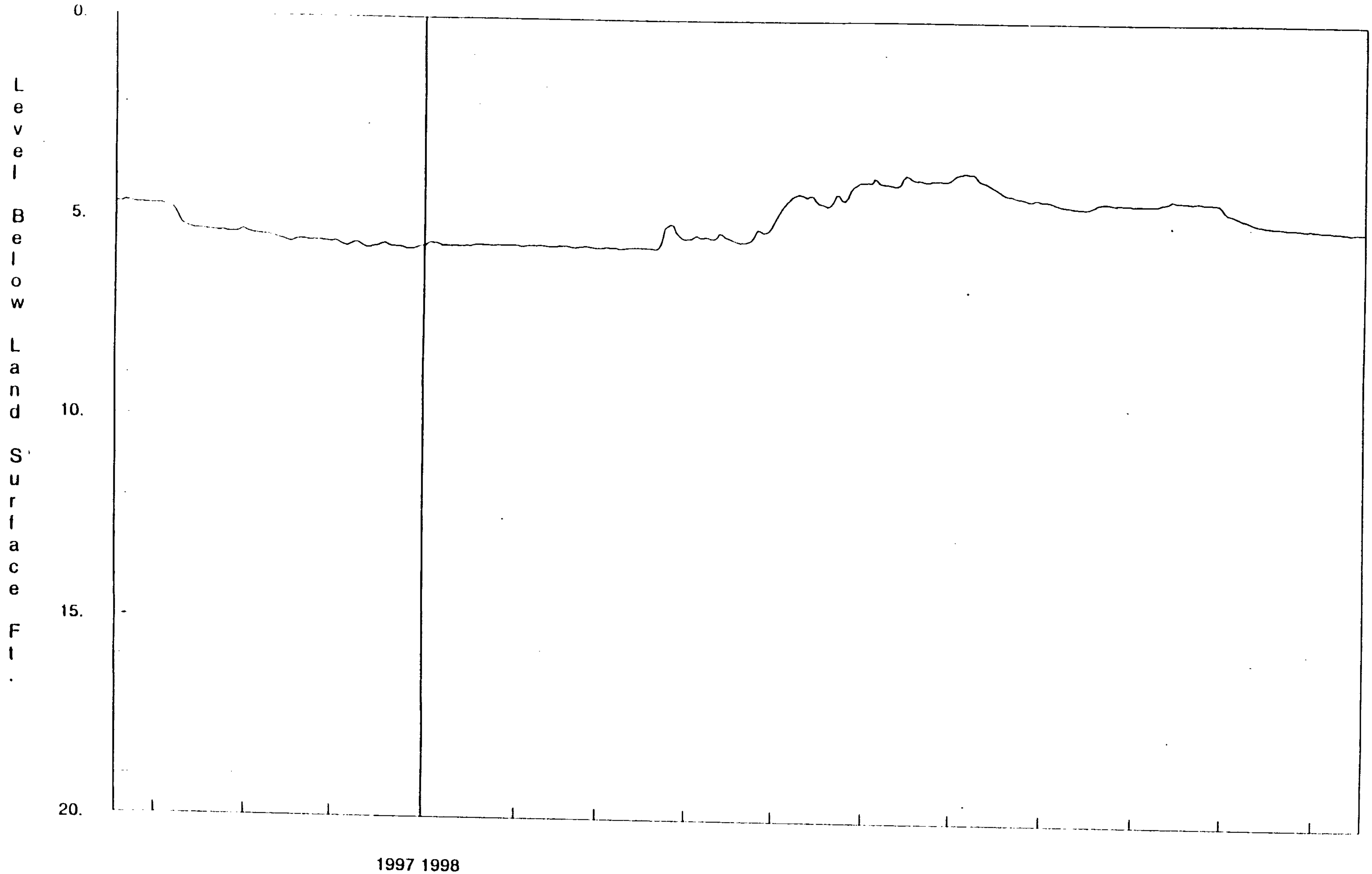


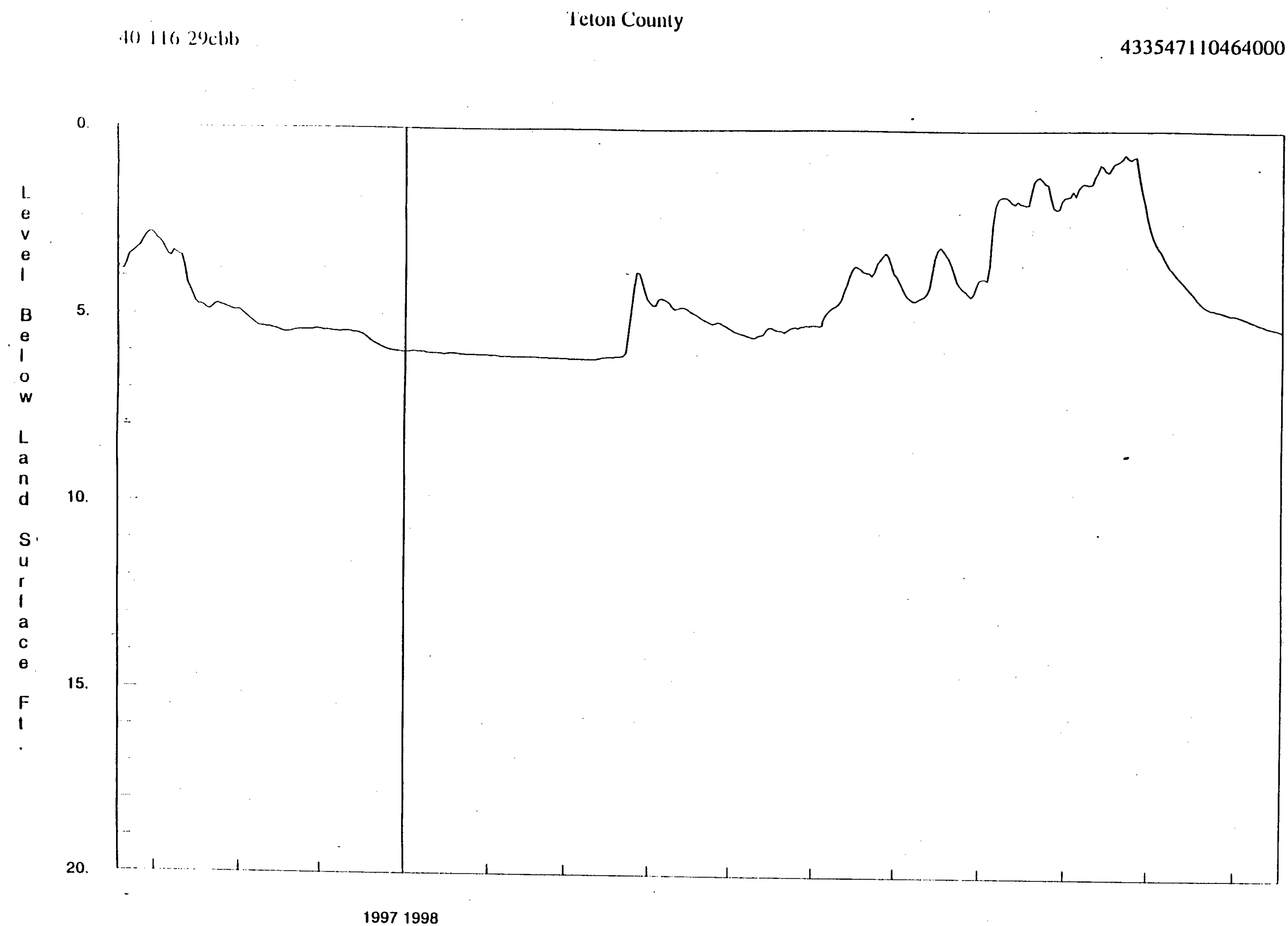
Lege ecorded Data ——— Prepared by the Wyoming State gineer's Office in Cooperation with T County February 1999

TC-13



Legend: Recorded Data ———

Prepared by the Wyoming State Engineer's Office in Cooperation with Te County



Leger ecorded Data ———— Prepared by the Wyoming Stat ineer's Office in Cooperation with Te County

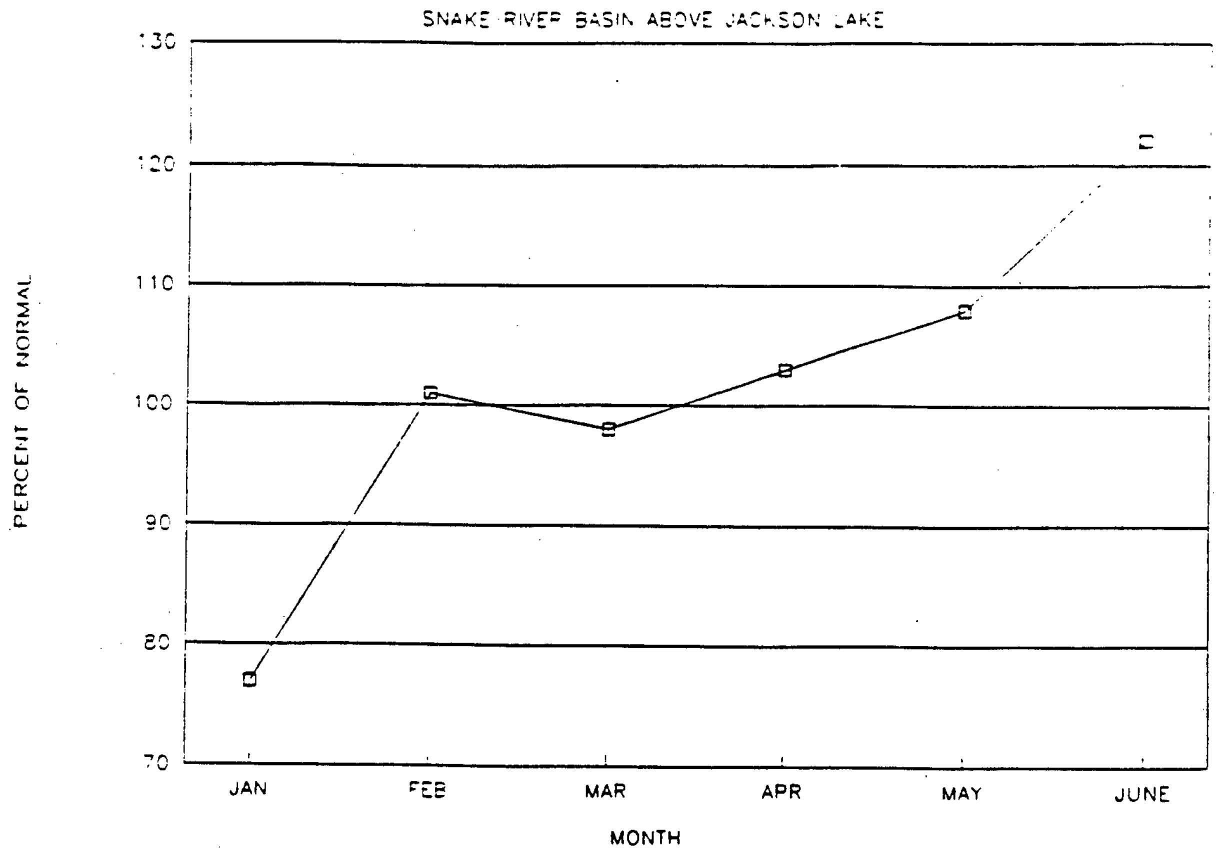
TC-15

PART VI. SURFACE WATER DATA

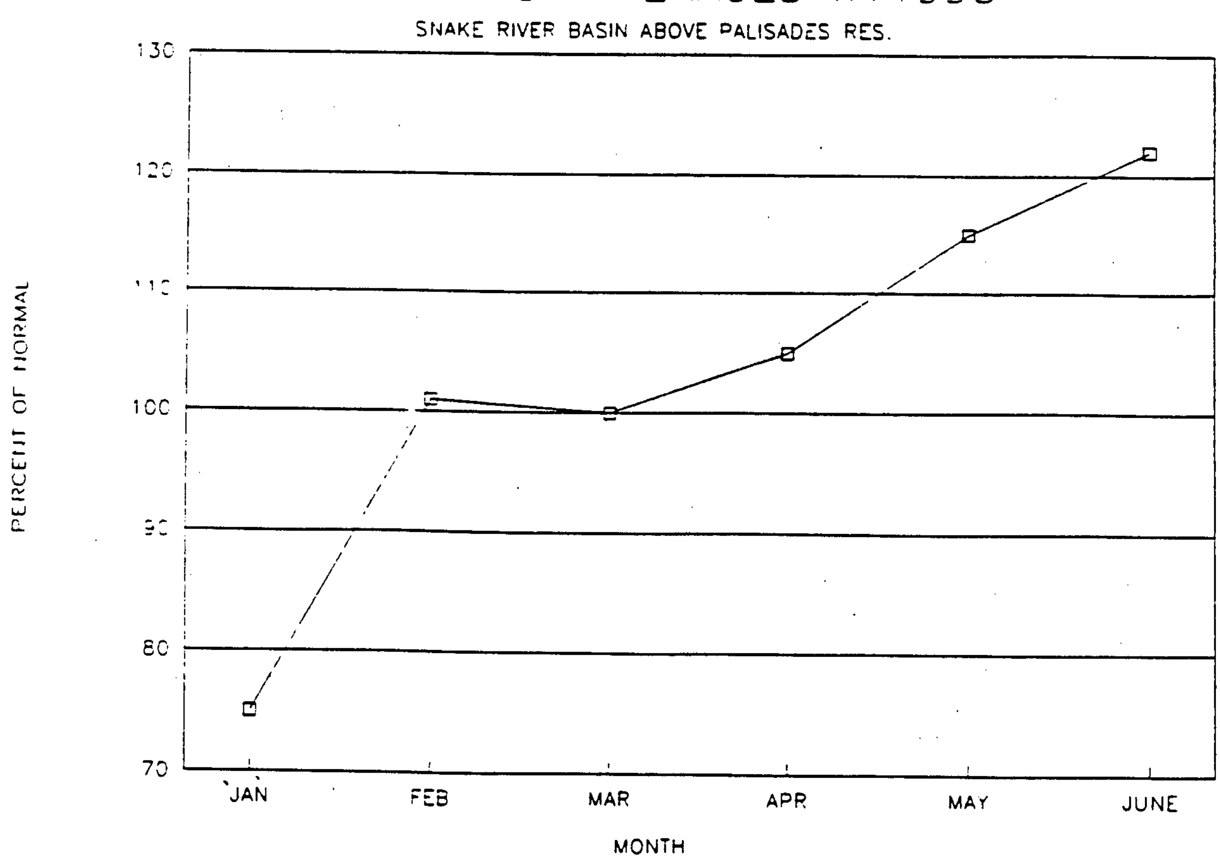
a) Hydrographer Annual Report

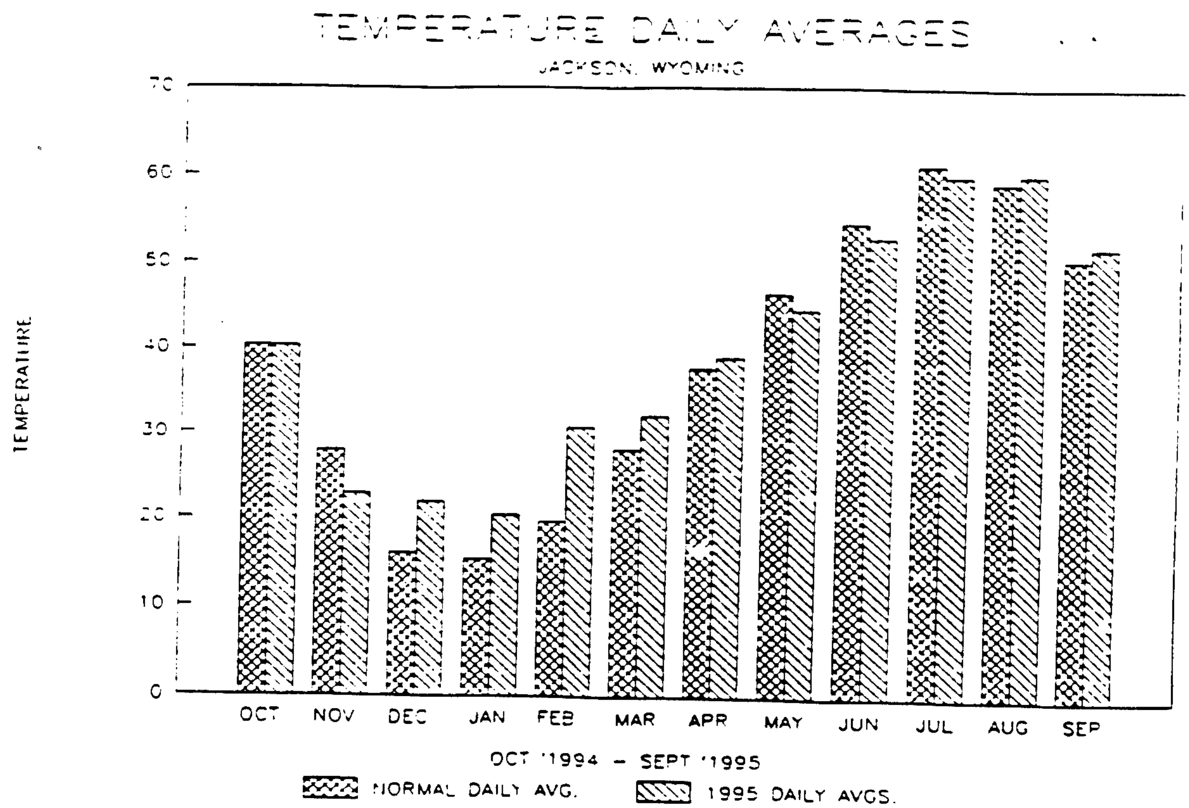
1. Stream & Diversion Report 1995

SNOW PACK AVERAGES WY1995



SNOW PACK AVERAGES WY1995

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JACKSON, WYOMING
TEMPERATURE
70
60
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40
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OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
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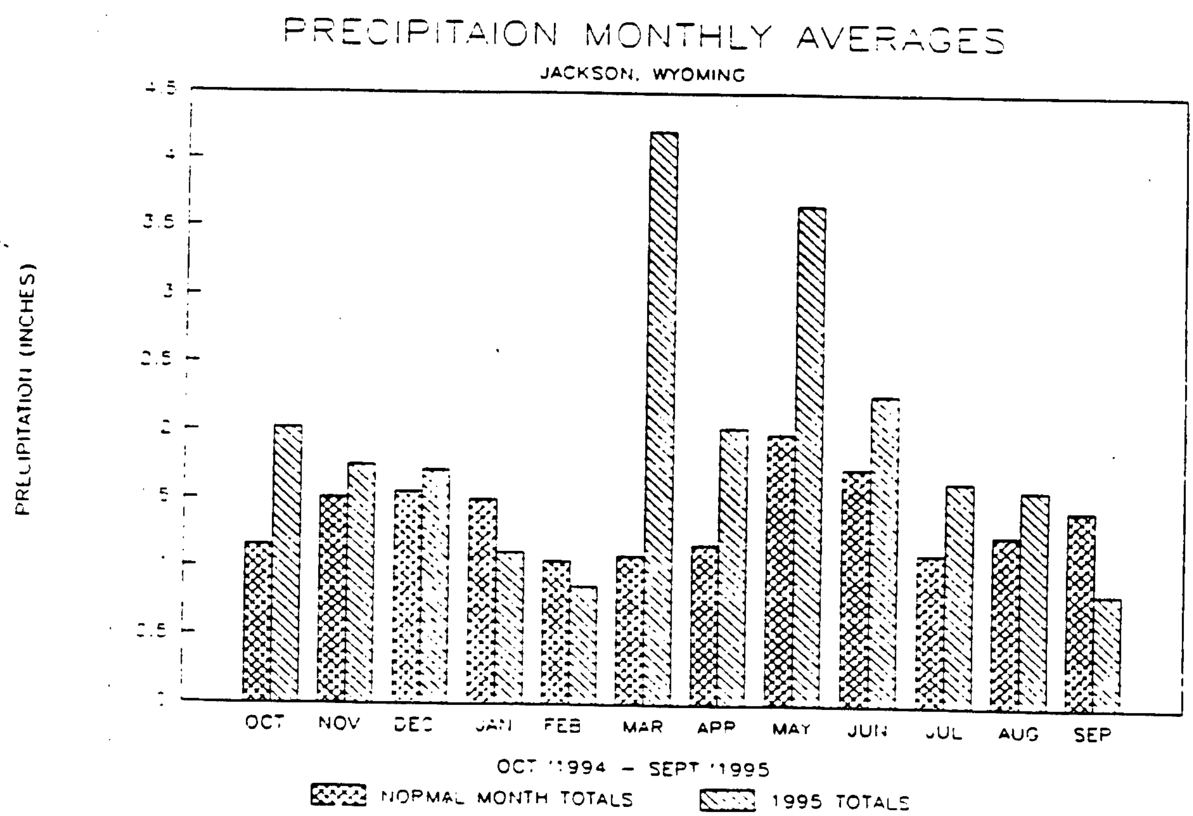
SEP
OCT '1994 – SEPT '1995
NORMAL DAILY AVG.
1995 DAILY AVGS.


PRECIPITAION MONTHLY AVERAGES
JACKSON, WYOMING
PRECIPITATION (INCHES)
4.5
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OCT
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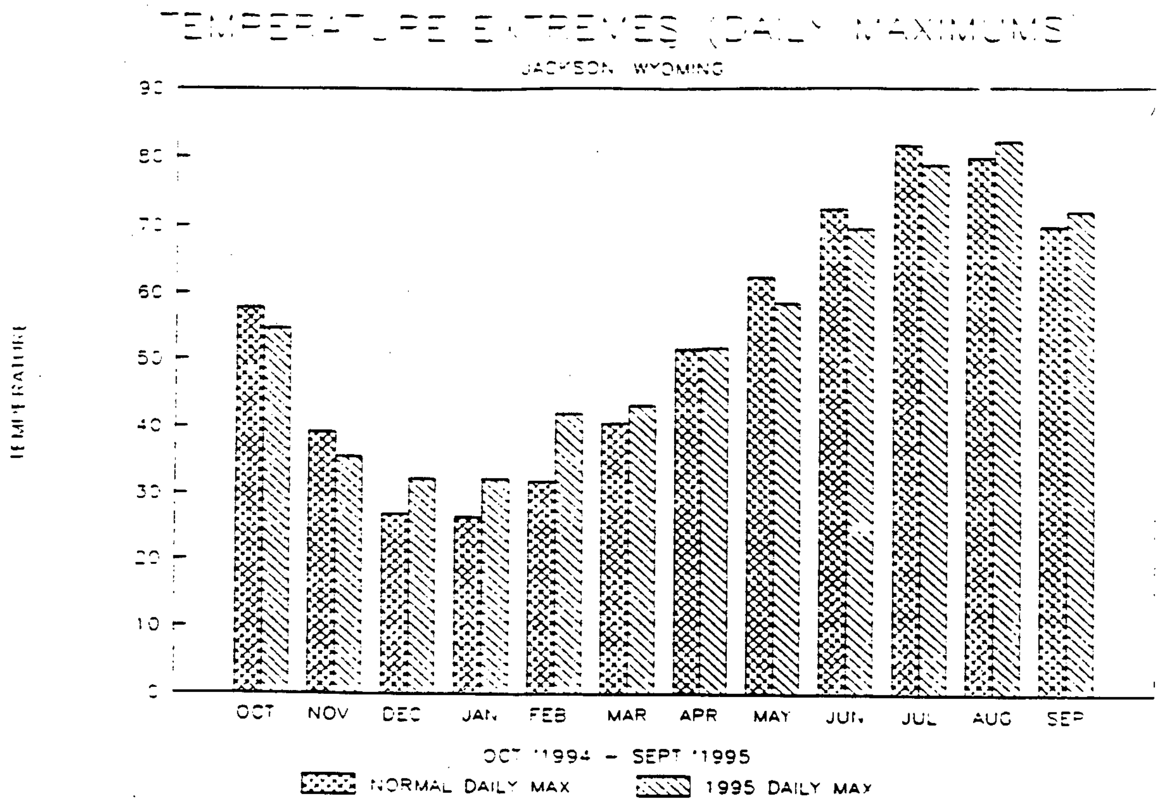
AUG
SEP
OCT '1994 – SEPT '1995
NORMAL MONTH TOTALS
1995 TOTALS


TEMPERATURE EXTREMES (DAILY MAXIMUMS)
JACKSON, WYOMING
TEMPERATURE
90
80
70
60
50
40
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20
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OCT
NOV
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JAN
FEB
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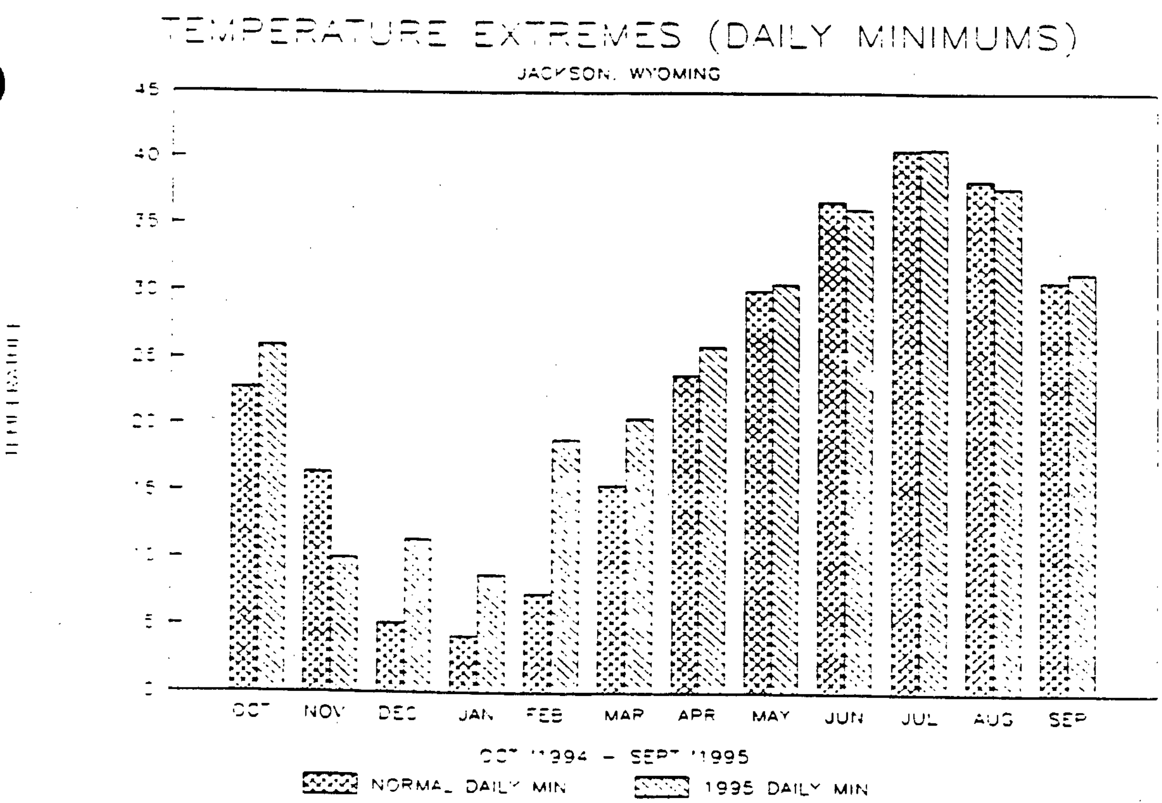
OCT '1994 - SEPT '1995
NORMAL DAILY MAX
1995 DAILY MAX


TEMPERATURE EXTREMES (DAILY MINIMUMS)
JACKSON, WYOMING
TEMPERATURE
45
40
35
30
25
20
15
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5
0
OCT
NOV
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JAN
FEB
MAR
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MAY
JUN
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SEP
OCT '1994 - SEPT '1995
NORMAL DAILY MIN
1995 DAILY MIN

FISH CREEK @ WILSON DITCH PERMITS: STREAM GAGE DISTRICT: 16
PRIORITY DATES:
SOURCE OF SUPPLY FISH CREEK. TRIB. SNAKE RIVER MEAS. DEVICE: USGS GAGE

DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART
10/5/1994	97.0R	2.53GH	10/13/1994	78.0R	2.39GH	10/27/1994	56.7R	2.31GH	11/4/1994	50.0R	2.22GH
3/28/1995	67.9R	1.93GH	4/7/1995	107.9R	2.32GH	4/17/1995	79.3R	2.12GH	4/25/1995	86.8R	2.05GH
5/5/1995	79.3R	2.12GH	5/10/1995	91.3R	2.22GH	5/19/1995	153.7R	2.50GH	5/26/1995	161.4R	2.54GH
6/1/1995	308R	3.15GH	6/7/1995	468R	3.64GH	6/13/1995	338R	3.25GH	6/21/1995	518R	3.77GH
6/30/1995	689M	2.53GH	7/6/1995	595R	3.92GH	7/13/1995	950R	4.59GH	7/20/1995	530R	3.80GH
7/26/1995	368R	3.35GH	8/3/1995	320R	3.09GH	8/10/1995	277R	3.04GH	8/16/1995	MISS	????
8/24/1995	259R	2.97GH	9/1/1995	231R	2.86GH	9/7/1995	222R	2.82GH	9/14/1995	143R	2.66GH
9/22/1995	127R	2.35GH	9/28/1995	125R	2.34GH						

PROSPERITY DITCH PERMITS: 5689, ETAL DISTRICT: 16
PRIORITY DATES: 12/2/1903
SOURCE OF SUPPLY SNAKE RIVER MEAS. DEVICE: 3.33' S.G.

DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART
10/5/1994	6.0E	4.06GH	10/13/1994	OFF	OFF	5/5/1995	OFF	OFF	5/10/1995	OFF	OFF
5/19/1995	OFF	OFF	5/26/1995	10.0E	4.41GH	6/1/1995	14E	4.80GH	6/7/1995	27E	5.06GH
6/13/1995	25E	4.93GH	6/21/1995	23E	4.90GH	6/30/1995	17E	4.85GH	7/6/1995	24.0E	4.94GH
7/13/1995	32E	5.20GH	7/20/1995	12.5E	4.76GH	7/26/1995	25.3E	4.99GH	8/3/1995	25.3E	4.99GH
8/10/1995	11.0E	4.43GH	8/16/1995	24.0E	4.94GH	8/24/1995	13E	4.49GH	9/1/1995	5.2E	3.96GH
9/7/1995	2.5E	3.74GH	9/14/1995	4.5E	3.87GH	9/22/1995	4.3E	3.85GH	9/28/1995	8.3R	4.35GH

BENNIE L. LINN DITCH PERMITS: 10611, ETAL DISTRICT: 16
PRIORITY DATES: 3/4/1911
SOURCE OF SUPPLY SNAKE RIVER MEAS. DEVICE: 2.07' S.G.

DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART
10/5/1994	1.0E	1.0E	10/13/1994	OFF	OFF	4/17/1995	OFF	OFF	4/25/1995	OFF	OFF
5/5/1995	OFF	OFF	5/10/1995	5.1R	0.38GH	5/19/1995	18.7M	0.96GH	5/26/1995	30.3M	1.28GH
6/1/1995	46.8M	1.78GH	6/7/1995	27.3R	1.26GH	6/13/1995	30.4R	1.36GH	6/21/1995	25.5R	1.20GH
6/30/1995	21.9R	1.08GH	7/6/1995	40.9R	1.68GH	7/13/1995	3.4E	0.29GH	7/20/1995	19.2R	0.98GH
7/26/1995	31.1R	1.38GH	8/3/1995	25.5R	1.20GH	8/10/1995	32.4M	1.44GH	8/16/1995	25.5R	1.20GH
8/24/1995	22.5R	1.10GH	9/1/1995	13.9R	0.78GH	9/7/1995	16.8R	0.89GH	9/14/1995	15.5R	0.84GH
9/22/1995	9.7R	.60GH	9/28/1995	8.4R	0.54GH						

WATER YEAR 1995 — DIVERSION RECORDS — WATER DIVISION I[illegible]

UYLER SNAKE RIVER DITCH — PERMITS: 17842. ETAL — DISTRICT: 16

PRIORITY DATES: 9/2/1930. ETAL

SOURCE OF SUPPLY SNAKE RIVER — MEAS. DEVICE: 3.33 S G

[illegible]	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART
5/10/1995	3.11M	0.67GH	5/19/1995	6.4M	0.79GH	5/26/1995	25.3M	1.23GH	6/1/1995	27.5R	1.26GH
6/7/1995	38R	1.40GH	6/13/1995	51M	1.55GH	6/21/1995	52.0R	1.56GH	6/30/1995	3.0R	0.64GH
7/6/1995	2.52R	0.63GH	7/13/1995	31R	1.28GH	7/20/1995	1.5E	0.41GH	7/26/1995	DRY	DRY
8/3/1995	6.5R	0.81GH	8/10/1995	OFF	OFF	8/16/1995	17.2R	1.08GH	8/24/1995	24.6R	1.20GH
9/1/1995	14.5R	1.09GH	9/7/1995	6.4R	0.80GH	9/14/1995	3.6R	0.68GH	9/22/1995	1.8R	0.56GH
9/28/1995	.5R	0.44GH									

GRANITE CREEK SUPPL. DITCH — PERMITS: 3384. ETAL — DISTRICT: 16

PRIORITY DATES: 8/26/1901. ETAL

SOURCE OF SUPPLY SNAKE RIVER — MEAS. DEVICE: 3.33' S.G.

DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART
10/5/1994	54.9R	0.76GH	10/13/1994	44.1R	0.66GH	10/27/1994	3.0E	3.0E	11/4/1994	OFF	OFF
5/10/1995	66.0M	0.94GH	5/19/1995	45.7R	0.64GH	5/26/1995	46.3R	0.65GH	6/1/1995	46.3R	0.65GH
6/7/1995	16.7R	0.14GH	6/13/1995	12R	0.08GH	6/21/1995	12.0R	0.08GH	6/30/1995	10.5M	1.86GH
7/6/1995	10.3R	1.85GH	7/13/1995	10.0R	1.78GH	7/20/1995	40.5R	2.26GH	7/26/1995	142R	3.37GH
[illegible]5	192R	3.76GH	8/10/1995	192R	3.76GH	8/16/1995	173R	3.64GH	8/24/1995	182R	3.70GH
[illegible]995	167R	3.60GH	9/7/1995	142R	3.42GH	9/14/1995	53.3R	2.61GH	9/22/1995	70.7R	2.88GH
9/28/1995	70.8R	2.84GH									

GRANITE CREEK @ GAGE DITCH — PERMITS: STREAM GAGE — DISTRICT: 16

PRIORITY DATES:

SOURCE OF SUPPLY GRANITE CREEK. TRIB. LAKE CREEK. TRIB. FISH CREEK — MEAS. DEVICE: 3.33' S.G.

DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART
10/5/1994	10.0E	0.88GH	10/13/1994	10.0E	0.88GH	10/27/1994	6.5E	0.86GH	11/4/1994	13.5R	0.93GH
3/28/1995	3.5E	3.5E	4/7/1995	4.0E	4.0E	4/25/1995	5.0E		5/5/1995	5.0E	
5/26/1995	77E	77E	6/1/1995	112E							

ARRIVE IS FLOW UPON ARRIVAL AT DITCH   DEPART IS FLOW AS LEFT WHEN LEAVING SITE   DATA COMPILED BY: LOREN SMITH

M = MEASURED FLOW   R = RATED FLOW   E = ESTIMATED FLOW   * = ROTATION INVOLVED

LAKE CK. @ HYWY390 DITCH PERMITS: STREAM GAGE DISTRICT: 1?
PRIORITY DATES:
SOURCE OF SUPPLY LAKE CREEK. TRIB. FISH CREEK. TRIB SNAKE RIVER MEAS. DEVICE: STAFF

DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART
10/27/1994	DRY	DRY	11/4/1994	DRY	DRY	3/28/1995	1.92M	0.19GH	4/7/1995	30.7R	0.86GH
4/17/1995	17.0R	0.66GH	5/5/1995	23.0R	0.76GH	5/10/1995	36.4R	0.92GH	5/19/1995	86.5R	1.27GH
6/1/1995	154.1R	1.55GH	6/7/1995	274R	1.95GH	6/13/1995	185R	1.65GH	6/21/1995	275R	1.96GH
6/30/1995	358R	2.28GH	7/6/1995	319R	2.10GH	7/13/1995	500E	2.82GH	7/20/1995	253M	1.92GH
7/26/1995	169R	1.60GH	8/3/1995	119R	1.42GH	8/10/1995	129R	1.46GH	8/16/1995	92.4R	1.30GH
8/24/1995	92.4R	1.30GH	9/1/1995	73.8R	1.20GH	9/7/1995	70.5R	1.18GH	9/14/1995	45.1R	1.00GH
9/22/1995	44R	0.99GH	9/28/1995	38.4R	0.94GH						

LAKE CK. ABV. GRANIT DITCH PERMITS: STREAM GAGE DISTRICT: 16
PRIORITY DATES:
SOURCE OF SUPPLY LAKE CREEK. TRIB. FISH CREEK. TRIB. SNAKE RIVER MEAS. DEVICE: 3.33'STAFF

DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART
10/5/1994	11.1R	0.44GH	10/13/1994	20.8R	0.59GH	10/27/1994	DRY	DRY	11/4/1994	DRY	DRY
3/28/1995	21.5M	0.59GH	4/7/1995	39.1M	0.76GH	4/17/1995	39.1R	0.76GH	4/25/1995	39.1R	0.76GH
5/5/1995	40.5M	0.82GH	5/10/1995	54.7M	0.92GH	5/19/1995	76.9M	1.06GH	5/26/1995	38.7R	0.74GH
6/1/1995	87.7M	1.17GH	6/7/1995	102.7R	1.36GH	6/13/1995	86R	1.16GH	6/21/1995	102R	1.35GH
6/30/1995	171R	1.55GH	7/6/1995	150R	1.48GH	7/13/1995	228M	1.98GH	7/20/1995	110R	1.26GH
7/26/1995	80R	1.09GH	8/3/1995	66R	1.00GH	8/10/1995	49.8R	0.88GH	8/16/1995	40.5R	0.80GH
8/24/1995	40.5R	0.80GH	9/1/1995	23R	0.60GH	9/7/1995	17.2R	0.54GH	9/14/1995	40.8M	0.84GH
9/22/1995	36.3R	0.76GH	9/28/1995	28.8R	0.65GH						

WATER YEAR 1995 | **DIVERSION RECORDS** | **WATER DIVISION IV**

LAKE CK. BL. GRANITE DITCH PERMITS: STREAM GAGE DISTRICT: 16

PRIORITY DATES:

SOURCE OF SUPPLY LAKE CREEK. TRIB. FISH CREEK. TRIB SNAKE RIVER MEAS. DEVICE: 3.33'STAFF

DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART
10/5/1994	21.2R	0.70GH	10/13/1994	21.2R	0.70GH	10/27/1994	DRY	DRY	11/4/1994	DRY	DRY
4/7/1995	40.2M	0.94GH	4/17/1995	39.0R	0.88GH	4/25/1995	39.0R	0.88GH	5/5/1995	42R	0.96GH
5/10/1995	60.3M	1.14GH	5/19/1995	101.7M	1.53GH	5/26/1995	61.0R	1.16GH	6/1/1995	155M	1.87GH
6/7/1995	203R	2.02GH	6/13/1995	123R	1.68GH	6/21/1995	156R	1.88GH	6/30/1995	218R	2.22GH
7/6/1995	176R	2.02GH	7/13/1995	363M	2.80GH	7/20/1995	165R	1.92GH	7/26/1995	106R	1.54GH
8/3/1995	77R	1.30GH	8/10/1995	74R	1.27GH	8/16/1995	59.0R	1.12GH	8/24/1995	54R	1.08GH
9/1/1995	47R	0.98GH	9/7/1995	37.7M	0.84GH	9/14/1995	39.8R	0.94GH	9/22/1995	37.7R	0.84GH
9/28/1995	37.8R	0.92GH									

FISH CK. @ SECT.2 DITCH PERMITS: STREAM GAGE DISTRICT: 16

PRIORITY DATES:

SOURCE OF SUPPLY FISH CREEK, TRIB. SNAKE RIVER MEAS. DEVICE: 3.33'STAFF

DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART
10/5/1994	28.9M	1.43GH	10/13/1994	22.1R	1.34GH	10/27/1994	14.8M	1.25GH	11/4/1994	13.5R	1.20GH
3/28/1995	16.5M	1.20GH	4/17/1995	25.0M	1.39GH	4/25/1995	24.3R	1.37GH	5/5/1995	24.3R	1.37GH
[illegible]5	25.0R	1.38GH	5/19/1995	29.9R	1.44GH	5/26/1995	50.6M	1.63GH	6/1/1995	67.5R	1.78GH
6/7/1995	150R	2.29GH	6/13/1995	125M	2.15GH	6/21/1995	193M	2.50GH	6/30/1995	219R	2.62GH
7/6/1995	193R	2.50GH	7/13/1995	213M	2.64GH	7/20/1995	174R	2.41GH	7/26/1995	152R	2.30GH
8/3/1995	119R	2.12GH	8/10/1995	116R	2.10GH	8/16/1995	106R	2.04GH	8/24/1995	110R	2.07GH
9/1/1995	97R	1.96GH	9/7/1995	98.5R	1.99GH	9/14/1995	47.9M	1.66GH	9/22/1995	41.3R	1.56GH
9/28/1995	35.0R	1.50GH									

WATER YEAR 1995 | **DIVERSION RECORDS** | **WATER DIVISION**

FISH CK. ABV. WILSON DITCH PERMITS: STREAM GAGE

PRIORITY DATES: DISTRICT: [illegible]

SOURCE OF SUPPLY FISH CREEK, TRIB. SNAKE RIVER MEAS. DEVICE: 3.33'STAFF

DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART
10/5/1994	107R	1.28GH	10/13/1994	85.5R	1.20GH	10/27/1994	56.4M	1.15GH	11/4/1994	80.8R	1.18GH
3/28/1995	58.4M	1.08GH	4/7/1995	123R	1.34GH	4/17/1995	95.9M	1.22GH	4/25/1995	85.5R	1.20GH
5/5/1995	98.8R	1.24GH	5/10/1995	109R	1.29GH	5/19/1995	165.6M	1.48GH	5/26/1995	174R	1.50GH
6/1/1995	317R	1.86GH	6/7/1995	496R	2.22GH	6/13/1995	374M	1.96GH	6/21/1995	568R	2.35GH
6/30/1995	660R	2.50GH	7/6/1995	610R	2.42GH	7/13/1995	851M	2.95GH	7/20/1995	527R	2.28GH
7/26/1995	382R	2.00GH	8/3/1995	322R	1.87GH	8/10/1995	304R	1.83GH	8/16/1995	290R	1.80GH
8/24/1995	273R	1.76GH	9/1/1995	248R	1.70GH	9/7/1995	196M	1.68GH	9/14/1995	160R	1.46GH
9/22/1995	140R	1.40GH	9/28/1995	129R	1.36GH						

VAN WINKLE @ GAGE DITCH PERMITS: 3542, 6817E, ETAL

PRIORITY DATES: 11/15/1901, 9/13/1985, ETAL DISTRICT: 16

SOURCE OF SUPPLY SNAKE RIVER MEAS. DEVICE: 3.33'STAFF

DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART
10/5/1994	5.8M	3.98GH	10/13/1994	1.5E	3.70GH	4/17/1995	2.3M	3.90GH	4/25/1995	3.0R	3.92GH
5/5/1995	9.05M	4.13GH	5/10/1995	13.5M	4.24GH	5/19/1995	24.1M	4.44GH	5/26/1995	24.9R	4.46GH
6/1/1995	14.5R	4.28GH	6/7/1995	13.5R	4.24GH	6/13/1995	22R	4.35GH	6/21/1995	13.5R	4.24GH
6/30/1995	15.7R	4.30GH	7/6/1995	14.1R	4.29GH	7/13/1995	OFF		7/20/1995	29.8M	4.50GH
7/26/1995	8.2R	4.09GH	8/3/1995	18.7R	4.38GH	8/10/1995	24R	4.44GH	8/16/1995	23.8R	4.42GH
8/24/1995	18.4R	4.37GH	9/1/1995	16.9R	4.32GH	9/7/1995	16.9R	4.32GH	9/14/1995	17.9M	4.33GH
9/22/1995	14.5R	4.27GH	9/28/1995	14.8R	4.29GH						

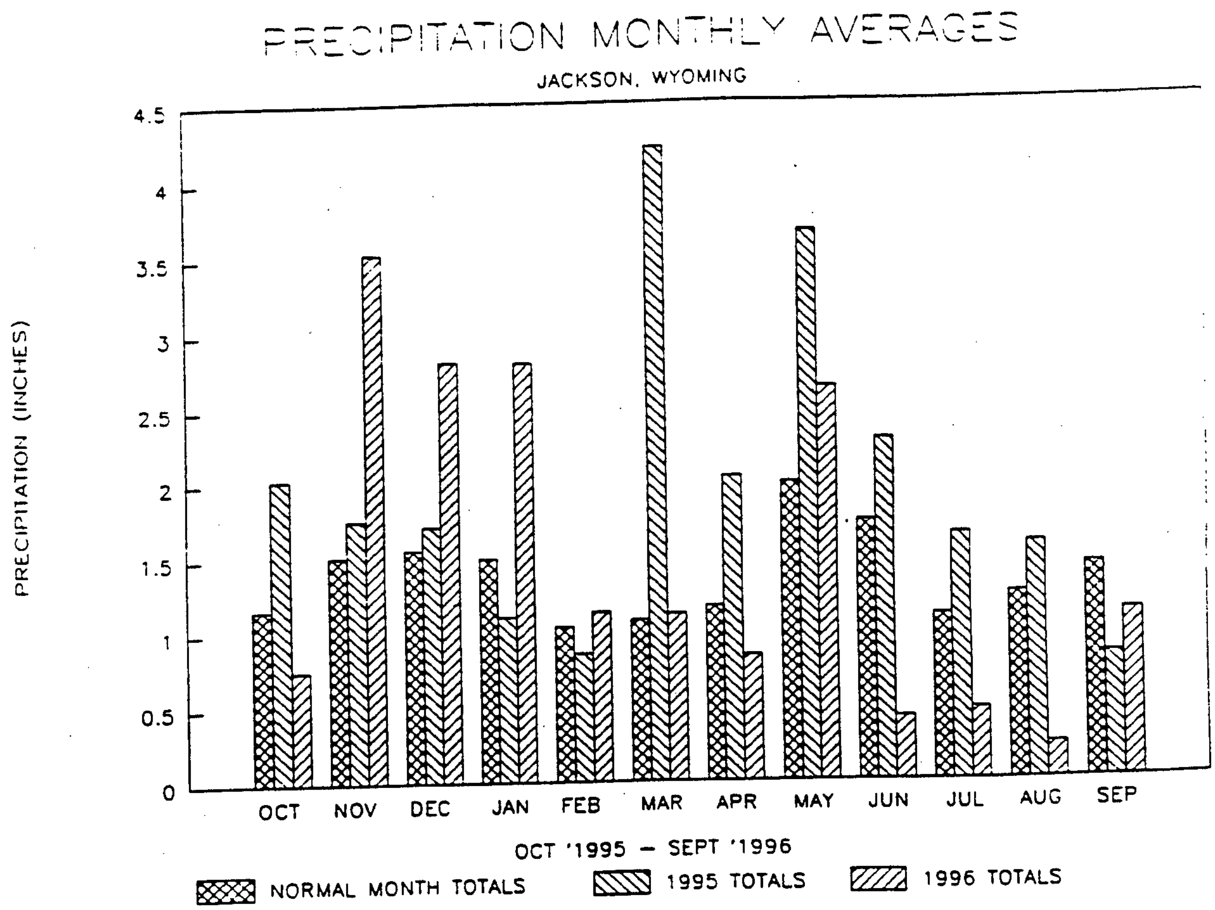
ARRIVE IS FLOW UPON ARRIVAL AT DITCH DEPART IS FLOW AS LEFT WHEN LEAVING SITE DATA COMPILED BY: LOREN SMITH

M = MEASURED FLOW R = RATED FLOW E = ESTIMATED FLOW * = ROTATION INVOLVED

PART VI. SURFACE WATER DATA

a) Hydrographer Annual Report

2. Stream & Diversion Report 1996


PRECIPITATION MONTHLY AVERAGES
JACKSON, WYOMING
PRECIPITATION (INCHES)
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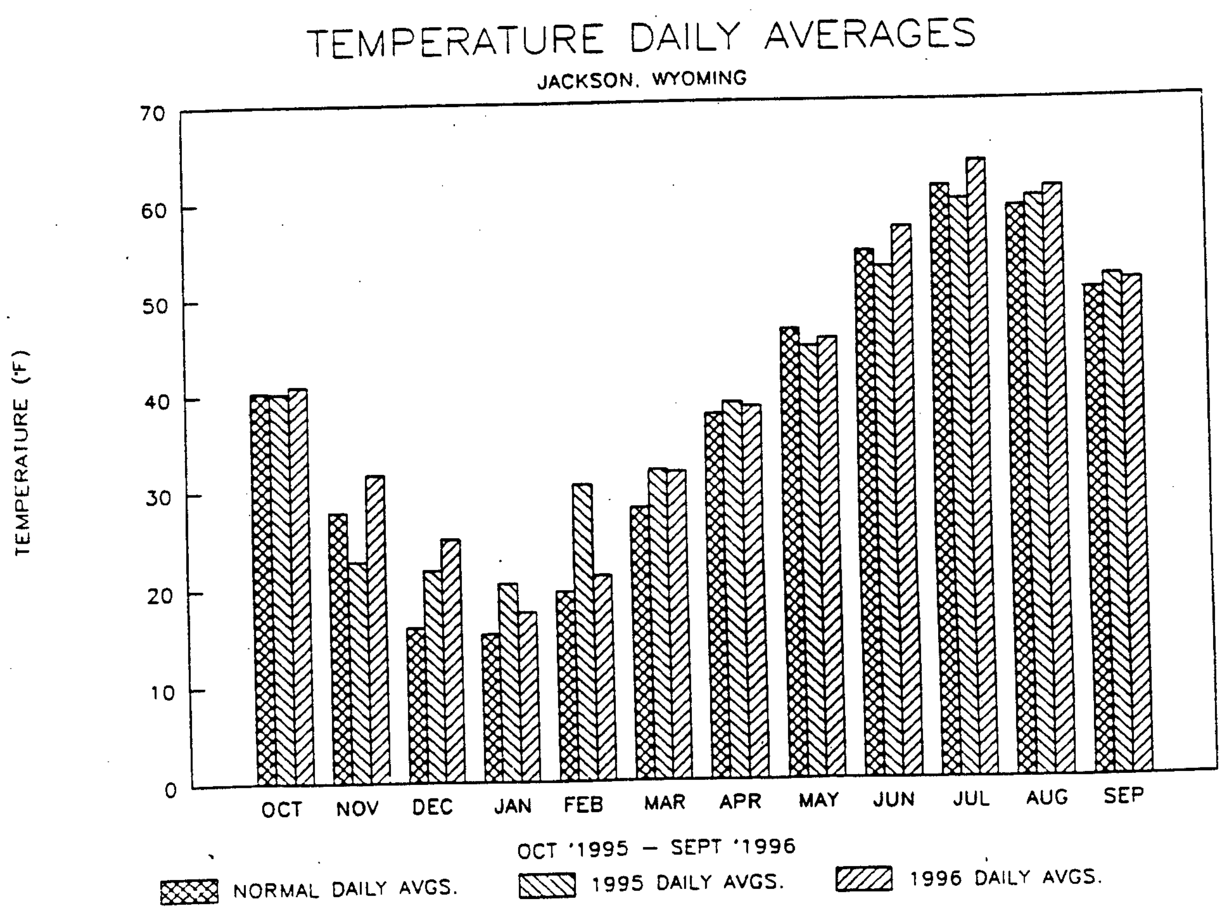
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP
OCT '1995 – SEPT '1996
NORMAL MONTH TOTALS
1995 TOTALS
1996 TOTALS


TEMPERATURE DAILY AVERAGES
JACKSON, WYOMING
TEMPERATURE (°F)
70
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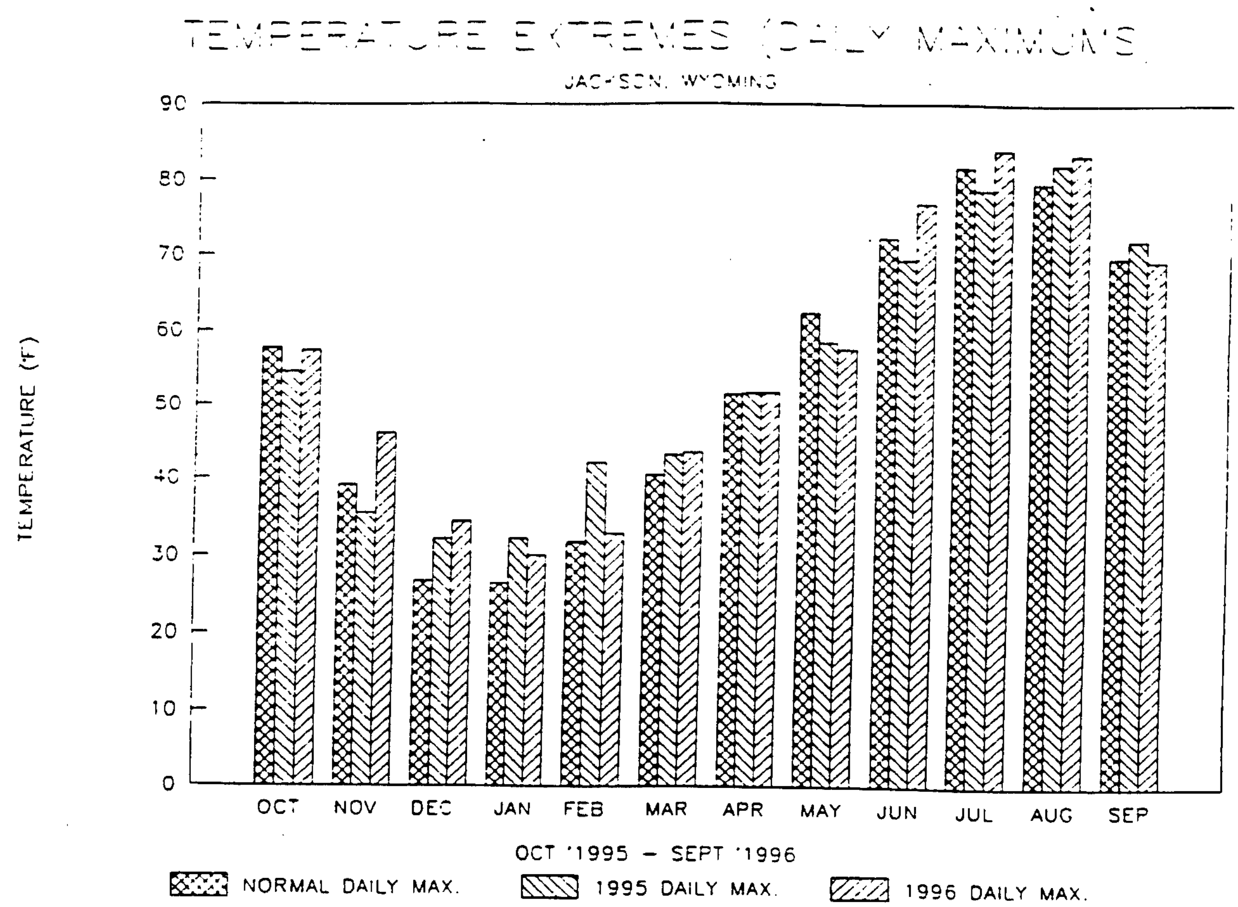
OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP
OCT '1995 – SEPT '1996
NORMAL DAILY AVGS.
1995 DAILY AVGS.
1996 DAILY AVGS.



TEMPERATURE EXTREMES (DAILY MAXIMUMS)
JACKSON, WYOMING
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TEMPERATURE (°F)
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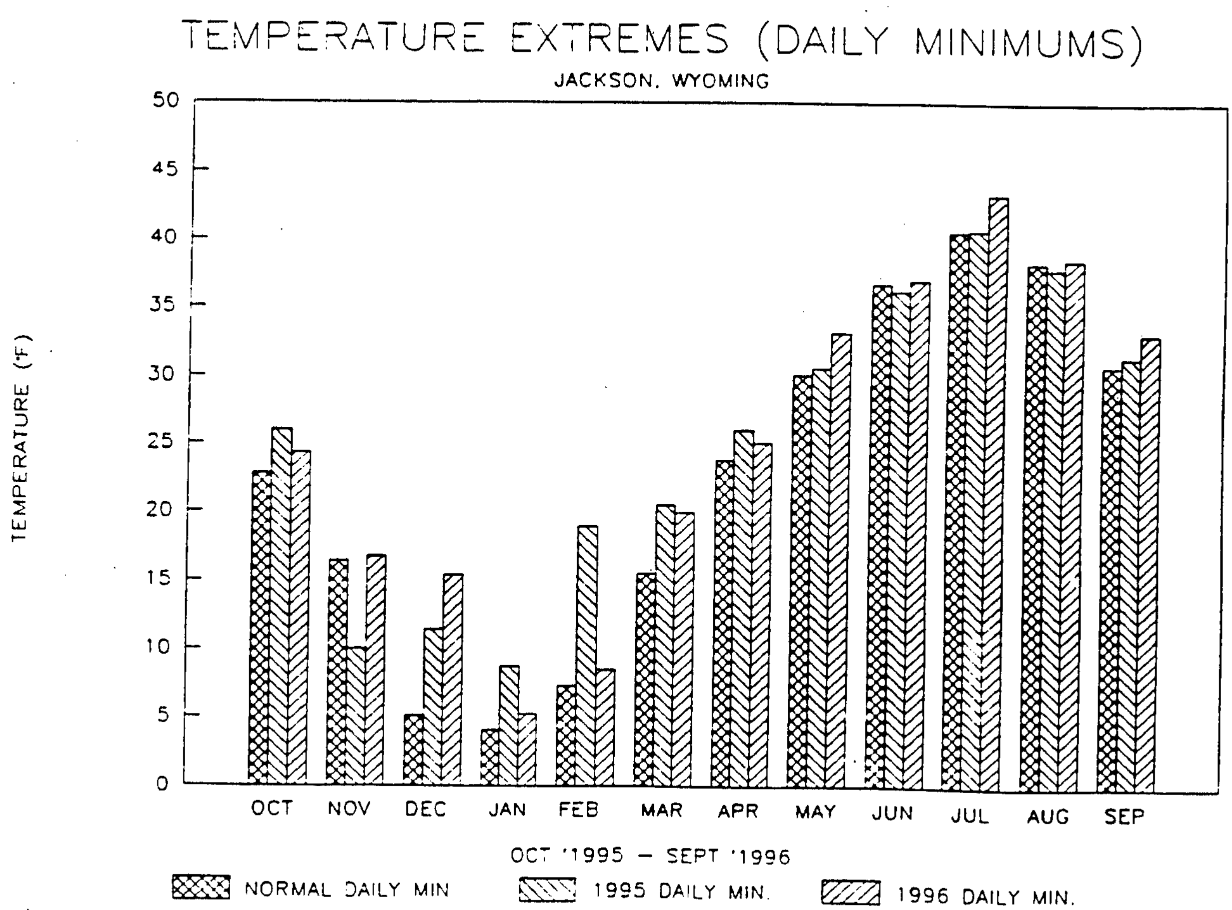
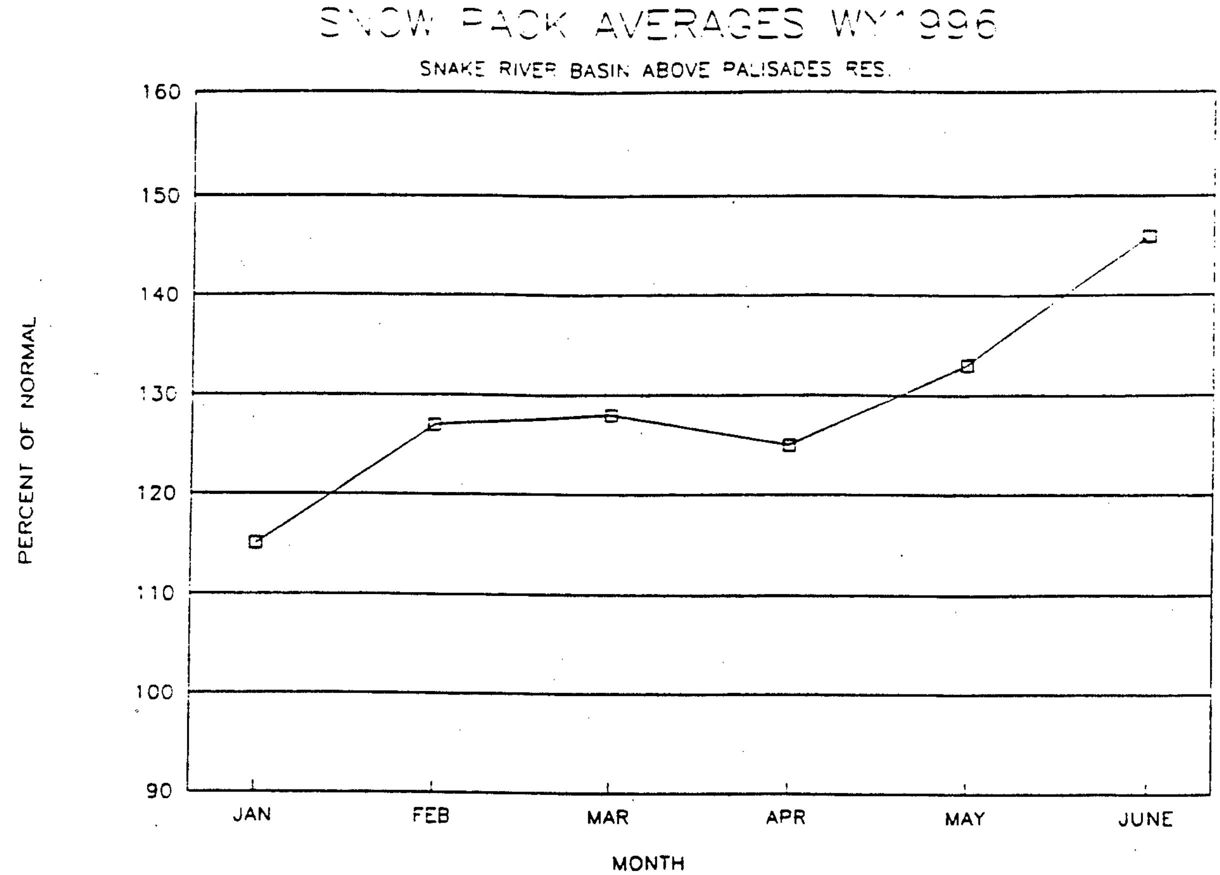
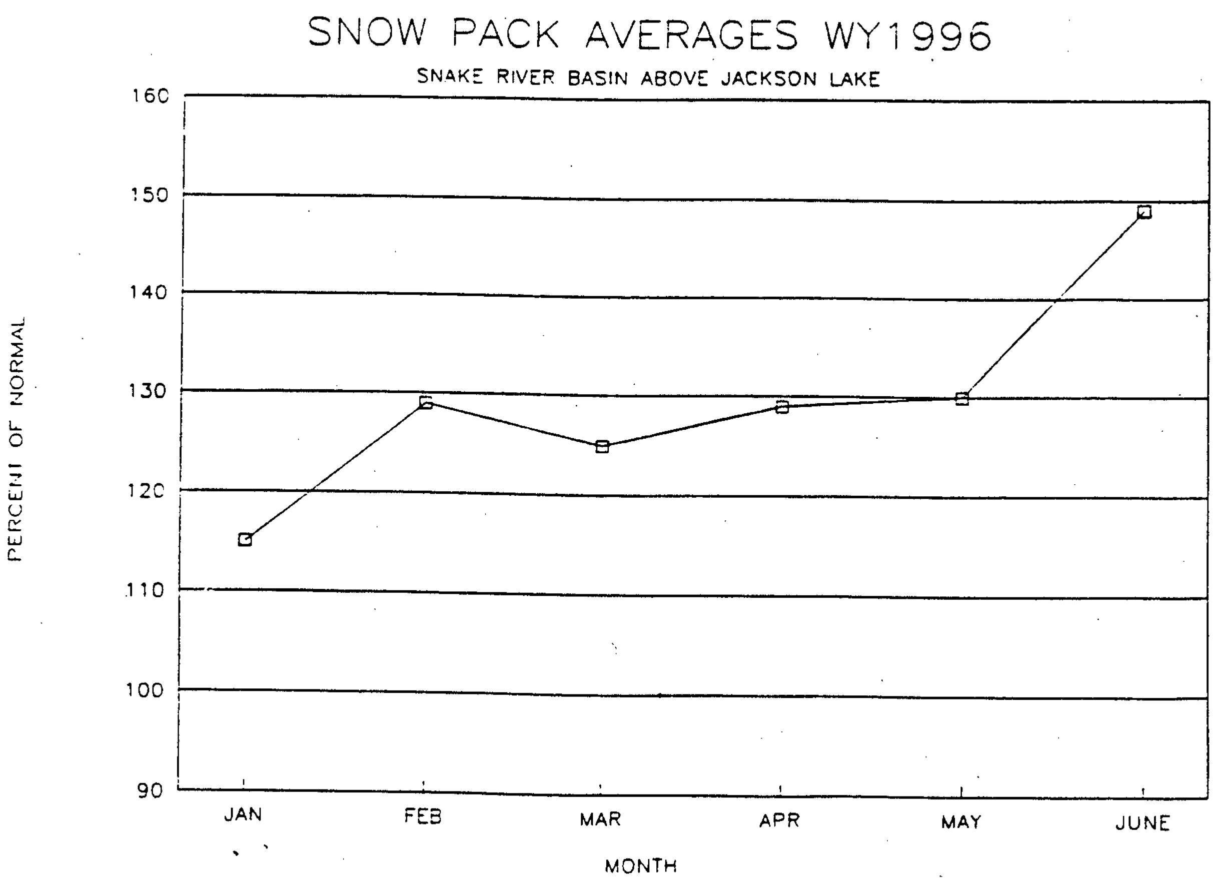
OCT '1995 – SEPT '1996
NORMAL DAILY MAX.
1995 DAILY MAX.
1996 DAILY MAX.



TEMPERATURE EXTREMES (DAILY MINIMUMS)
JACKSON, WYOMING
50
45
40
35
30
25
20
15
10
5
0
TEMPERATURE (°F)
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT '1995 – SEPT '1996
NORMAL DAILY MIN
1995 DAILY MIN.
1996 DAILY MIN.


SNOW PACK AVERAGES WY1996
SNAKE RIVER BASIN ABOVE PALISADES RES.
PERCENT OF NORMAL
160
150
140
130
120
110
100
90
JAN
FEB
MAR
APR
MAY
JUNE
MONTH


SNOW PACK AVERAGES WY1996
SNAKE RIVER BASIN ABOVE JACKSON LAKE
PERCENT OF NORMAL
160
150
140
130
120
110
100
90
JAN
FEB
MAR
APR
MAY
JUNE
MONTH

WATER YEAR 1996 | DIVERSION RECORDS | WATER DIVISION IV

PROSPERITY DITCH PERMITS: 5689, ETAL

PRIORITY DATES: 12/2/1903 DISTRICT: 16

SOURCE OF SUPPLY SNAKE RIVER MEAS. DEVICE: 3.33' S.G

DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART
0/25/1995	OFF	OFF	11/8/1995	OFF	OFF	4/22/1996	6.5E	3.88GH	5/7/1996	5.5E	3.83GH
5/23/1996	5.5E	3.83GH	5/30/1996	4.3R	3.76GH	6/7/1996	12.5E	4.76GH	6/14/1996	23.0E	4.90GH
/21/1996	12.0E	4.75GH	6/28/1996	20.5E	4.87GH	7/5/1996	17.5E	4.85GH	7/11/1996	10.5R	4.56GH
7/18/1996	8.0E	3.94GH	7/26/1996	11.0E	4.63GH	8/2/1996	4.5R	3.79GH	8/9/1996	4.8R	3.81GH
/16/1996	2.5R	3.51GH	8/22/1996	2.5R	3.51GH	8/29/1996	3.5E	3.76GH	9/6/1996	2.8R	3.56GH
9/13/1996	2.5E	3.52GH	9/27/1996	1.5E	1.5E						

BENNIE L. LINN DITCH PERMITS: 10611, ETAL

PRIORITY DATES: 3/4/1911 DISTRICT: 16

SOURCE OF SUPPLY SNAKE RIVER MEAS. DEVICE: 2.07' S.G.

DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART
0/11/1995	OFF	OFF	10/25/1995	OFF	OFF	11/8/1995	OFF	OFF	4/22/1996	2.2R	0.21GH
5/7/1996	23.5R	1.20GH	5/16/1996	13.4R	0.76GH	5/23/1996	20.3R	1.02GH	5/30/1996	19.4R	0.99GH
6/7/1996	18.7R	0.96GH	6/14/1996	33.6M	1.45GH	6/21/1996	24.9R	1.18GH	6/28/1996	38.5R	1.61GH
7/5/1996	43.4R	1.75GH	7/11/1996	10.2R	0.62GH	7/18/1996	14.4R	0.80GH	7/26/1996	40.9R	1.68GH
8/2/1996	38.1M	1.52GH	8/9/1996	29.8R	1.26GH	8/16/1996	49.3R	1.84GH	8/22/1996	45.3M	1.77GH
3/29/1996	42.3R	1.69GH	9/6/1996	40.9R	1.68GH	9/13/1996	35.6R	1.52GH	9/27/1996	30.7R	1.37GH

AN WINKLE @ GAGE DITCH PERMITS: 3542, 6817E, ETAL

PRIORITY DATES: 11/15/1901, 9/13/1985, ETAL DISTRICT: 16

SOURCE OF SUPPLY SNAKE RIVER MEAS. DEVICE: 3.33'STAFF

DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART
0/11/1995	3.94R	3.94GH	10/25/1995	OFF	OFF	11/8/1995	OFF	OFF	4/22/1996	2.0R	3.90GH
5/7/1996	2.5R	3.91GH	5/16/1996	12.3M	4.25GH	5/23/1996	20.5R	4.55GH	5/30/1996	10.9R	4.24GH
6/7/1996	10.0R	4.20GH	6/14/1996	12.2R	4.30GH	6/21/1996	10.9R	4.24GH	6/28/1996	10.9R	4.24GH
7/5/1996	9.7R	4.18GH	7/11/1996	9.7R	4.18GH	7/18/1996	12.7R	4.32GH	7/26/1996	20.2M	4.42GH
8/2/1996	16.6R	4.32GH	8/9/1996	14.0R	4.24GH	8/16/1996	20.0R	4.41GH	8/22/1996	16.6M	4.39GH
/29/1996	16.6R	4.39GH	9/6/1996	14.0R	4.37GH	9/13/1996	9.7R	4.18GH	9/27/1996	9.0E	9.0E

ARRIVE IS FLOW UPON ARRIVAL AT DITCH DEPART IS FLOW AS LEFT WHEN LEAVING SITE DATA COLLECTED BY: LOREN SMITH

= MEASURED FLOW R = RATED FL

/ATER YEAR 1996 | DIVERSION RECORDS | WATER DIVISION

UYLER SNAKE RIVER DITCH | PERMITS: 17842. ETAL | DISTRICT: 16

RIORITY DATES: 9/2/1930, ETAL

OURCE OF SUPPLY SNAKE RIVER | MEAS. DEVICE: 3.33 S.G

DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART
0/11/1995	2.0E	0.30GH	10/25/1995	2.0E	0.22GH	11/8/1995	OFF	OFF	5/7/1996	OFF	OFF
5/16/1996	14.1R	1.02GH	5/23/1996	23.2R	1.18GH	5/30/1996	35.2R	1.34GH	6/7/1996	32R	1.30GH
6/14/1996	14.5R	1.04GH	6/21/1996	2.5E	0.48GH	6/28/1996	34.6M	1.11GH	7/5/1996	60.5R	1.35GH
7/11/1996	47.0R	1.48GH	7/18/1996	46.7M	1.33GH	7/26/1996	62.4R	1.40GH	8/2/1996	55R	1.32GH
8/9/1996	55.9R	1.33GH	8/16/1996	62.4R	1.40GH	8/22/1996	55.3R	1.30GH	8/29/1996	55.3R	1.30GH
9/6/1996	48.8R	1.50GH	9/13/1996	47.9R	1.49GH	9/27/1996	2.20R	0.60GH			

RANITE CREEK SUPPL. DITCH | PERMITS: 3384. ETAL | DISTRICT: 16

'RIORITY DATES: 8/26/1901, ETAL

OURCE OF SUPPLY SNAKE RIVER | MEAS. DEVICE: 3.33' S.G.

DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART
10/11/1995	56.6R	2.64GH	10/25/1995	10.0E	1.71GH	11/8/1995	2.5E	2.5E	5/7/1996	3.5E	1.55GH
5/16/1996	4.5E	1.65GH	5/23/1996	7.5R	1.73GH	5/30/1996	7.8R	1.75GH	6/7/1996	21.9R	2.73GH
6/14/1996	5.0E	1.70GH	6/21/1996	5.0E	1.70GH	6/28/1996	5.0E	1.70GH	7/5/1996	67.3R	2.82GH
7/11/1996	9.8R	1.85GH	7/18/1996	42.4R	2.49GH	7/26/1996	95.7R	3.15GH	8/2/1996	83.6R	3.03GH
1996	169R	3.52GH	8/16/1996	195.4R	3.92GH	8/22/1996	185R	3.85GH	8/29/1996	182R	3.80GH
996	178M	3.68GH	9/13/1996	149R	3.57GH	9/27/1996	86.5R	3.03GH			

ISH CREEK @ WILSON DITCH | PERMITS: STREAM GAGE | DISTRICT: 16

PRIORITY DATES:

SOURCE OF SUPPLY FISH CREEK, TRIB. SNAKE RIVER | MEAS. DEVICE: USGS GAGE

DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART
10/11/1995	100R	2.40GH	10/25/1995	70.6R	2.21GH	11/8/1995	83.2R	2.10GH	4/10/1996	75.5R	2.12GH
4/22/1996	80.6R	2.13GH	5/7/1996	43.5R	1.75GH	5/16/1996	277.3R	3.04GH	5/23/1996	283R	3.06GH
5/30/1996	422R	3.52GH	6/7/1996	775R	4.35GH	6/14/1996	978R	4.96GH	6/21/1996	852R	4.50GH
6/28/1996	862R	4.52GH	7/5/1996	857R	4.51GH	7/11/1996	566R	3.89GH	7/18/1996	425R	3.52GH
7/26/1996	320E	3.15GH	8/2/1996	283R	3.02GH	8/9/1996	254R	2.91GH	8/16/1996	241R	2.87GH
8/22/1996	256R	2.96GH	8/29/1996	269.3R	2.97GH	9/6/1996	213M	2.80GH	9/13/1996	179.5R	2.63GH
9/27/1996	171.3R	2.59GH									

ARRIVE IS FLOW UPON ARRIVAL AT DITCH   DEPART IS FLOW AS LEFT WHEN LEAVING SITE   DATA COLLECTED BY: LOREN SMITH

M = MEASURED FLOW   R = RATED FLOW   E = ESTIMATED FLOW   * = ROTATION INVOLVED   DATA COMPILED BY: LOREN SMITH

WATER YEAR 1996 | DIVERSION RECORDS | WATER DIVISION I

FISH CK. ABV. WILSON DITCH PERMITS: STREAM GAGE

PRIORITY DATES: DISTRICT: 16

SOURCE OF SUPPLY FISH CREEK. TRIB. SNAKE RIVER MEAS. DEVICE: 3.33'STAFF

DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART
10/11/1995	107R	1.28GH	10/25/1995	71.4R	1.14GH	11/8/1995	54.6M	1.09M	4/10/1996	75.7R	1.18GH
4/22/1996	82.5R	1.21GH	5/7/1996	90.0R	1.24GH	5/16/1996	334R	1.93GH	5/23/1996	319R	1.90GH
5/30/1996	460R	2.18GH	6/7/1996	926M	2.91GH	6/14/1996	1100R	3.20GH	6/21/1996	885R	2.85GH
6/28/1996	892R	2.86GH	7/5/1996	885R	2.85GH	7/11/1996	560R	2.36GH	7/18/1996	408R	2.08GH
7/26/1996	273M	1.88GH	8/2/1996	243R	1.81GH	8/9/1996	199R	1.70GH	8/16/1996	199R	1.70GH
8/22/1996	207R	1.72GH	8/29/1996	223R	1.76GH	9/6/1996	195R	1.60GH	9/13/1996	173R	1.53GH
9/27/1996	152M	1.46GH									

FISH CK. @ SECT.2 DITCH PERMITS: STREAM GAGE

PRIORITY DATES: DISTRICT: 16

SOURCE OF SUPPLY FISH CREEK. TRIB. SNAKE RIVER MEAS. DEVICE: 3.33'STAFF

DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART
10/11/1995	25.8R	1.39GH	10/25/1995	18.6R	1.29GH	11/8/1995	11.6M	1.18GH	4/10/1996	15.8M	1.28GH
4/22/1996	29.1R	1.43GH	5/7/1996	35.0R	1.50GH	5/16/1996	64.5M	1.83GH	5/23/1996	128R	2.24GH
5/30/1996	180R	2.44GH	6/7/1996	289R	2.92GH	6/14/1996	303R	2.98GH	6/21/1996	258R	2.79GH
6/28/1996	171M	2.50GH	7/5/1996	171R	2.50GH	7/11/1996	148R	2.38GH	7/18/1996	148R	2.28GH
7/26/1996	106R	2.14GH	8/2/1996	103M	2.09GH	8/9/1996	88R	2.00GH	8/16/1996	77.5R	1.92GH
8/22/1996	89.5R	2.00GH	8/29/1996	102R	2.08GH	9/6/1996	85.0R	1.90GH	9/13/1996	83.5R	1.89GH
9/27/1996	47.9R	1.62GH									

LAKE CK. @ HYWY390 DITCH PERMITS: STREAM GAGE

PRIORITY DATES: DISTRICT: 16

SOURCE OF SUPPLY LAKE CREEK. TRIB. FISH CREEK. TRIB. SNAKE RIVER MEAS. DEVICE: STAFF

DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART
10/11/1995	19.3R	0.70GH	10/25/1995	DRY	DRY	11/8/1995	DRY	DRY	4/10/1996	DRY	DRY
4/22/1996	6.8R	0.40GH	5/7/1996	DRY	DRY	5/16/1996	241.8M	1.87GH	5/23/1996	114R	1.47GH
5/30/1996	286R	1.90GH	6/7/1996	400E	2.55GH	6/14/1996	500E	3.08GH	6/21/1996	500E	2.78GH
6/28/1996	600E	2.88GH	7/5/1996	700E	3.03GH	7/11/1996	301M	2.20GH	7/18/1996	203R	1.70GH
7/26/1996	119R	1.42GH	8/2/1996	104.3M	1.32GH	8/9/1996	86.8R	1.24GH	8/16/1996	90.5R	1.26GH
8/22/1996	92.4R	1.27GH	8/29/1996	86.1M	1.24GH	9/6/1996	72.2R	1.19GH	9/13/1996	62.8R	1.13GH
9/27/1996	64.4R	1.14GH									

ARRIVE IS FLOW UPON ARRIVAL AT DITCH **DEPART** IS FLOW AS LEFT WHEN LEAVING SITE DATA COLLECTED BY: LOREN SMITH

M = MEASURED FLOW R = RATED FLOW E = ESTIMATED FLOW * = ROTATION INVOLVED DATA COMPILED BY: LOREN SMITH

AKE CK. BL. GRANITE DITCH PERMITS: STREAM GAGE DISTRICT: 16

'RIORITY DATES: MEAS. DEVICE: 3.33'STAFF

;OURCE OF SUPPLY LAKE CREEK, TRIB. FISH CREEK, TRIB. SNAKE RIVER

DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART
[illegible]1/1995	31.4R	0.83GH	10/25/1995	5.5E	0.36GH	11/8/1995	DRY	DRY	4/10/1996	DRY	DRY
4/22/1996	12.0E	0.38GH	5/7/1996	9.5E	0.40GH	5/16/1996	220R	2.20GH	5/23/1996	97.6R	1.48GH
5/30/1996	163R	1.90GH	6/7/1996	353M	2.74GH	6/14/1996	468R	3.10GH	6/21/1996	336.8R	2.72GH
6/28/1996	426R	3.00GH	7/5/1996	426R	3.00GH	7/11/1996	269M	2.30GH	7/18/1996	137.5R	1.75GH
7/26/1996	95.2R	1.32GH	8/2/1996	78.8R	1.18GH	8/9/1996	72.9M	1.12GH	8/16/1996	71.2R	1.11GH
8/22/1996	71.2R	1.11GH	8/29/1996	63.9R	1.04GH	9/6/1996	57.7R	1.12GH	9/13/1996	49.7R	1.04GH
9/27/1996	66.0R	1.20GH									

AKE CK. ABV. GRANIT DITCH PERMITS: STREAM GAGE DISTRICT: 16

PRIORITY DATES: MEAS. DEVICE: 3.33'STAFF

SOURCE OF SUPPLY LAKE CREEK, TRIB. FISH CREEK, TRIB. SNAKE RIVER

DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART
10/11/1995	32.1R	0.72GH	10/25/1995	4.5E	0.21GH	11/8/1995	DRY	DRY	4/10/1996	DRY	DRY
[illegible]22/1996	14.5R	0.05GH	5/7/1996	9.5R	0.41GH	5/16/1996	161R	1.58GH	5/23/1996	73.5R	1.05GH
5/30/1996	128R	1.39GH	6/7/1996	192M	1.96GH	6/14/1996	265R	2.33GH	6/21/1996	248R	2.04GH
6/28/1996	318R	2.40GH	7/5/1996	292R	2.47GH	7/11/1996	154R	1.74GH	7/18/1996	79.5M	1.30GH
[illegible]3/1996	40.5R	1.01GH	8/2/1996	27.5R	0.88GH	8/9/1996	37.6M	0.98GH	8/16/1996	39.4R	0.90GH
8/22/1996	27.5R	0.67GH	8/29/1996	19.4R	0.78GH	9/6/1996	15.9R	0.52GH	9/13/1996	9.5R	0.41GH
9/27/1996	28.5M	0.68GH									

ARRIVE IS FLOW UPON ARRIVAL AT DITCH DEPART IS FLOW AS LEFT WHEN LEAVING SITE DATA COLLECTED BY: LOREN SMIT

M = MEASURED FLOW R = RATED FLOW E = ESTIMATED FLOW * = ROTATION INVOLVED DATA COMPILED BY: LOREN SMIT

PART VI. SURFACE WATER DATA

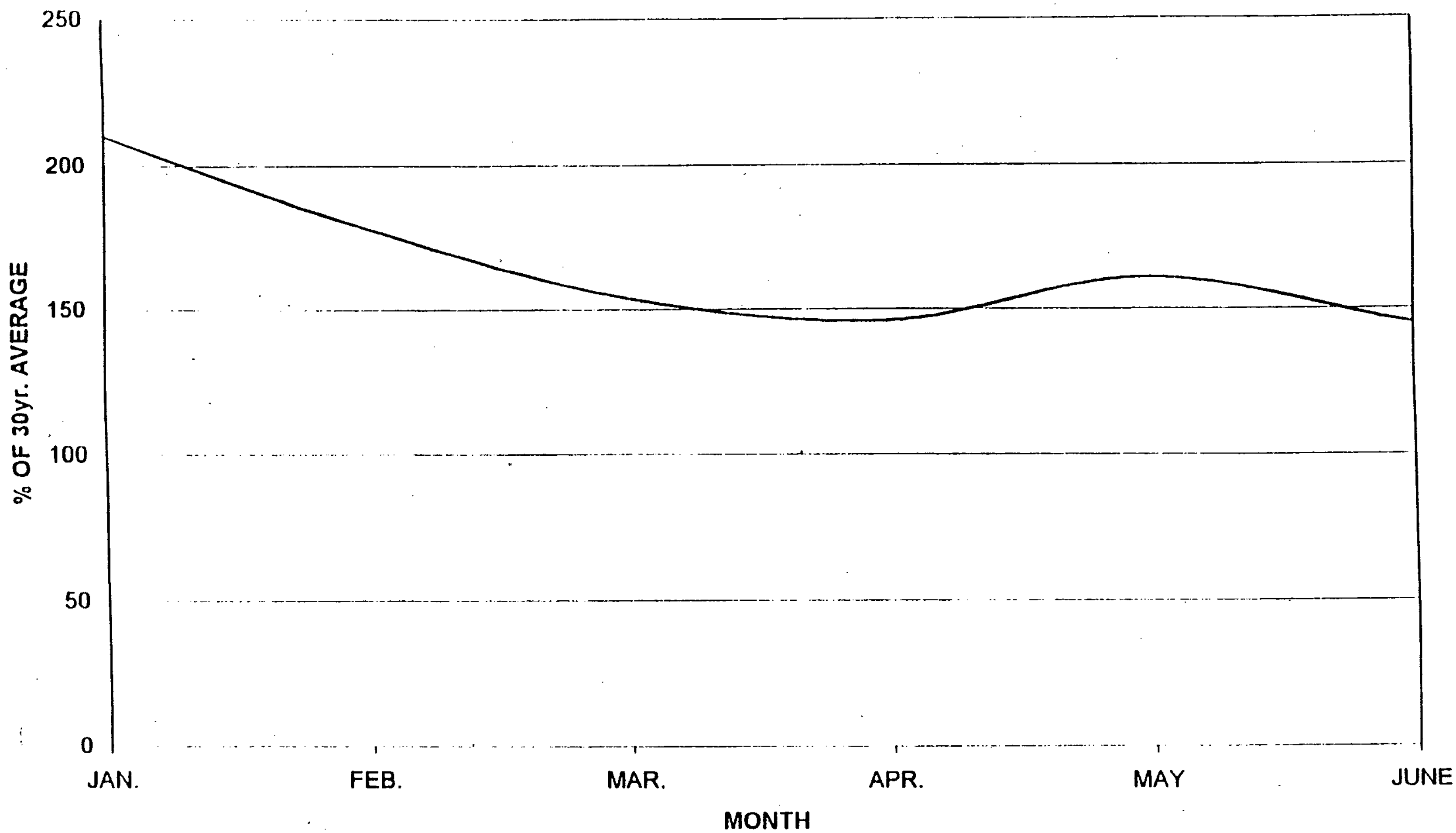
a) Hydrographer Annual Report

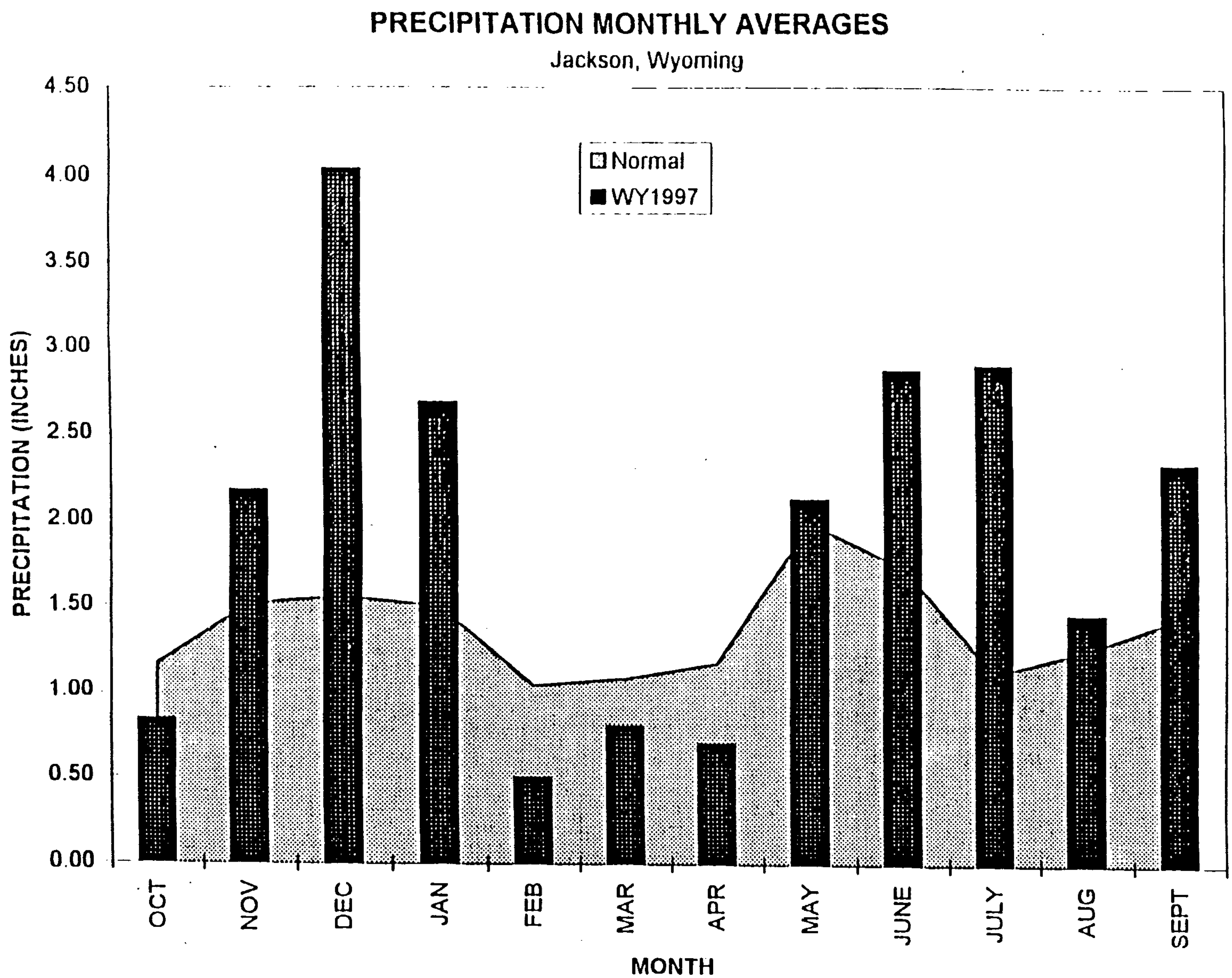
3. Stream & Diversion Report 1997

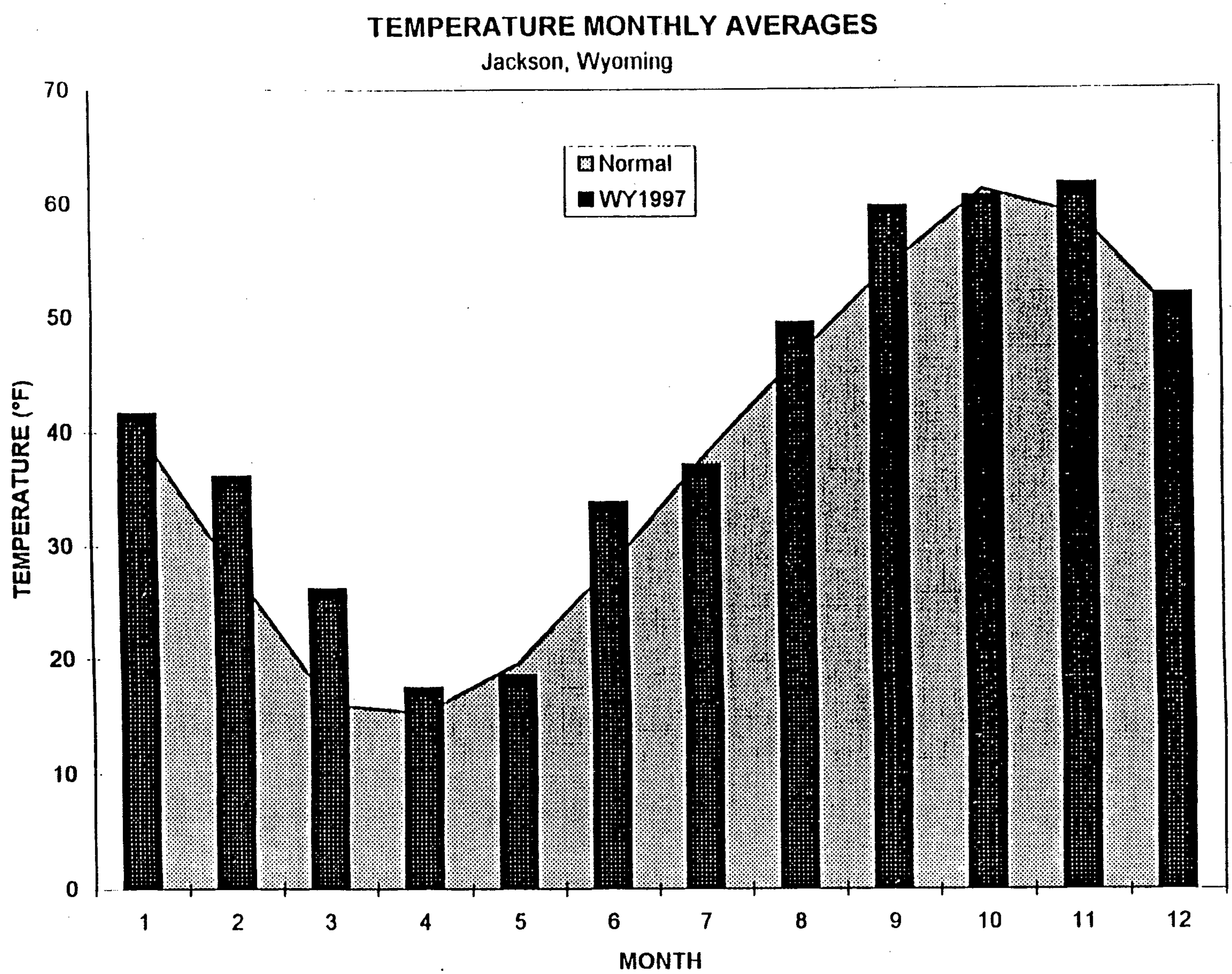
SNOW PACK AVERAGES

SNAKE RIVER BASIN ABOVE PALISADES RESERVOIR

WY 1997




PRECIPITATION MONTHLY AVERAGES
Jackson, Wyoming
Normal
WY1997
PRECIPITATION (INCHES)
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
MONTH


TEMPERATURE MONTHLY AVERAGES
Jackson, Wyoming
Normal
WY1997
TEMPERATURE (°F)
0
10
20
30
40
50
60
70
1
2
3
4
5
6
7
8
9
10
11
12
MONTH

WATER YEAR 1997 | **DIVERSION RECORDS** | **WATER DIVISION [illegible]**

PROSPERITY DITCH PERMITS: 5689, ETAL — DISTRICT: 16

PRIORITY DATES: 12/2/1903

SOURCE OF SUPPLY SNAKE RIVER — MEAS. DEVICE: 3.33' S.G

DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART
10/11/96	1.0E	1.0E	10/25/96	1.0E	1.0E	4/17/97	0.5E	0.5E	4/30/97	0.5E	0.5E
5/8/97	OFF	OFF	5/21/97	3.5E	3.5E	5/30/97	12.5E	12.5E	6/5/97	21.0E	21.0E
6/10/97	20.0E	20.0E	6/18/97	24E	24E	6/26/97	6.5E	6.5E	7/3/97	5.0E	5.0E
7/11/97	5.2E	5.2E	7/18/97	9.0E	9.0E	7/25/97	3.8R	3.8R	7/31/97	12.5E	12.5E
8/8/97	3.5E	3.5E	8/12/97	2.8E	2.8E	8/22/97	4.0E	4.0E	8/29/97	4.0E	4.0E
9/5/97	4.0E	4.0E	9/12/97	3.8E	3.8E	9/26/97	2.5E	2.5E			

BENNIE L. LINN DITCH PERMITS: 10611, ETAL — DISTRICT: 16

PRIORITY DATES: 3/4/1911

SOURCE OF SUPPLY SNAKE RIVER — MEAS. DEVICE: 2.07' S.G.

DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART
10/11/96	16.0R	16.0R	10/25/96	13.9R	13.9R	4/17/97	OFF	OFF	4/30/97	OFF	OFF
5/8/97	OFF	OFF	5/21/97	18.2R	18.2R	5/30/97	26.7M	26.7M	6/5/97	16.7R	16.7R
6/10/97	3.9R	3.9R	6/18/97	29.3M	29.3M	6/26/97	31.6R	31.6R	7/3/97	7.7R	7.7R
7/11/97	1.7R	1.7R	7/18/97	31.6R	31.6R	7/25/97	61.1R	61.1R	7/31/97	27.4M	27.4M
8/8/97	22.0R	22.0R	8/12/97	22.9R	22.9R	8/22/97	17.6R	17.6R	8/29/97	14.5R	14.5R
9/5/97	12.8M	12.8M	9/12/97	12.6R	12.6R	9/26/97	11.1R	11.1R			

VAN WINKLE @ GAGE DITCH PERMITS: 3542, 6817E, ETAL — DISTRICT: 16

PRIORITY DATES: 11/15/1901, 9/13/1985, ETAL

SOURCE OF SUPPLY SNAKE RIVER — MEAS. DEVICE: 3.33'STAFF

DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART
10/11/96	OFF	OFF	10/25/96	OFF	OFF	4/17/97	OFF	OFF	4/30/97	OFF	OFF
5/8/97	OFF	OFF	5/21/97	19.9R	19.9R	5/30/97	9.7M	9.7M	6/5/97	4.1R	4.1R
6/10/97	8.5R	8.5R	6/18/97	12.3R	12.3R	6/26/97	18..3M	18..3	7/3/97	8.7R	8.7R
7/11/97	16.8R	16.8R	7/18/97	15.1R	15.1R	7/25/97	14.8R	14.8R	7/31/97	13.0R	13.0R
8/8/97	15.8R	15.8R	8/12/97	15.7M	15.7M	8/22/97	13.0R	13.0R	8/29/97	14.1R	14.1R
9/5/97	11.4R	11.4R	9/12/97	10.4R	10.4R	9/26/97	7.1M	7.1M			

ARRIVE IS FLOW UPON ARRIVAL AT DITCH **DEPART** IS FLOW AS LEFT WHEN LEAVING SITE

M = MEASURED FLOW R = RATED FLOW E = ESTIMATED FLOW * = ROTATION INVOLVED

DATA COLLECTED BY: LOREN SMITH, DON BARNEY & CONAN BEESLEY

DATA COMPILED BY: LOREN SMITH

HUYLER SNAKE RIVER DITCH PERMITS: 17842, ETAL DISTRICT: 15

[PRIO]RITY DATES: 9/2/1930, ETAL MEAS. DEVICE: 3.33 S.G

[SOU]RCE OF SUPPLY SNAKE RIVER

DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART
10/11/96	OFF	OFF	10/25/96	OFF	OFF	4/17/97	OFF	OFF	4/30/97	OFF	OFF
5/8/97	OFF	OFF	5/21/97	30.5R	30.5R	5/30/97	6.1M	6.1M	6/5/97	33.6R	33.6R
6/10/97	14.5R	14.5R	6/18/97	5.4R	5.4R	6/26/97	13.6R	13.6R	7/3/97	43.8M	43.8M
7/11/97	48.8R	48.8R	7/18/97	52.4R	52.4R	7/25/97	29R	29R	7/31/97	35.2R	35.2R
8/8/97	30.5R	30.5R	8/12/97	26.1R	26.1R	8/22/97	65.1M	65.1M	8/29/97	46.2R	46.2R
9/5/97	50.6R	50.6R	9/12/97	64.2R	64.2R	9/26/97	34.4R	34.4R			

GRANITE CREEK SUPPL. DITCH PERMITS: 3384, ETAL DISTRICT: 16

PRIORITY DATES: 8/26/1901, ETAL MEAS. DEVICE: 3.33' S.G.

SOURCE OF SUPPLY SNAKE RIVER

DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART
10/11/96	59.9R	59.9R	10/25/96	5.5R	5.5R	4/17/97	OFF	OFF	4/30/97	OFF	OFF
5/8/97	OFF	OFF	5/21/97	2.6M	2.6M	5/30/97	2.6R	2.6R	6/5/97	2.5E	2.5E
6/10/97	2.5E	2.5E	6/18/97	2.5E	2.5E	6/26/97	2.0E	2.0E	7/3/97	2.0E	2.0E
7/11/97	65.6R	65.6R	7/18/97	115R	115R	7/25/97	108R	108R	7/31/97	86.8R	86.8R
8/8/97	72.5R	72.5R	8/12/97	58.6M	58.6M	8/22/97	95.6R	95.6R	8/29/97	76.1R	76.1R
9/5/97	78.9R	78.9R	9/12/97	127.3R	127.3	9/26/97	105.3R	105.3			

FISH CREEK @ WILSON DITCH PERMITS: STREAM GAGE DISTRICT: 16

PRIORITY DATES: MEAS. DEVICE: USGS GAGE

SOURCE OF SUPPLY FISH CREEK, TRIB. SNAKE RIVER

DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART
10/11/96	84.5R	84.5R	10/25/96	107.4R	107.4	4/17/97	75.5R	75.5R	4/30/97	144.3R	144.3
5/8/97	130.2R	2.37G	5/21/97	468R*	468R*	5/30/97	702R	702R	6/5/97	1218R	1218R
6/10/97	1400R	1400R	6/18/97	1250E	1250E	6/26/97	483R	483R	7/3/97	446R	446R
7/11/97	365R	365R	7/18/97	457R	457R	7/25/97	402R	402R	7/31/97	381R	381R
8/8/97	264R	264R	8/12/97	269R	269R	8/22/97	205.6R	205.6	8/29/97	171R	171R
9/5/97	148R	148R	9/12/97	175R	175R	9/26/97	163R	163R			

ARRIVE IS FLOW UPON ARRIVAL AT DITCH DEPART IS FLOW AS LEFT WHEN LEAVING SITE

M = MEASURED FLOW R = RATED FLOW E = ESTIMATED FLOW * = ROTATION INVOLVED

DATA COLLECTED BY: LOREN SMITH, DON BARNEY & CONAN BEESLEY

DATA COMPILED BY: LOREN SMITH

FISH CK. ABV. WILSON DITCH PERMITS: STREAM GAGE DISTRICT:

PRIORITY DATES:

SOURCE OF SUPPLY FISH CREEK, TRIB. SNAKE RIVER MEAS. DEVICE: 3.33'STAFF

DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART
10/11/96	71.5R	71.5R	10/25/96	85.0R	85.0R	4/17/97	80.6M	80.6M	4/30/97	176R	176R
5/8/97	157R	1.46G	5/21/97	629R	629R	5/30/97	928R	928R	6/5/97	1276M	1276
6/10/97	1600E	1600E	6/18/97	1300E	1300E	6/26/97	480R	480R	7/3/97	565M	565M
7/11/97	565R	565R	7/18/97	475R	475R	7/25/97	418R	418R	7/31/97	376M	376M
8/8/97	293R	293R	8/12/97	271R	271R	8/22/97	203R	203R	8/29/97	176R	176R
9/5/97	151R	151R	9/12/97	176R	176R	9/26/97	150M	150M			

FISH CK. @ SECT.2 DITCH PERMITS: STREAM GAGE DISTRICT: 16

PRIORITY DATES:

SOURCE OF SUPPLY FISH CREEK, TRIB. SNAKE RIVER MEAS. DEVICE: 3.33'STAFF

DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART
10/11/96	24.3R	24.3R	10/25/96	17.5R	17.5R	4/17/97	19.0E	19.0E	4/30/97	59.6M	59.6M
5/8/97	51.5R	1.25G	5/21/97	175M	175M	5/30/97	237R	237R	6/5/97	333M	333M
6/10/97	321R	321R	6/18/97	249R	249R	6/26/97	154R	154R	7/3/97	121R	121R
7/11/97	131R	131R	7/18/97	114R	114R	7/25/97	98.5R	98.5R	7/31/97	143M	143M
8/8/97	106R	106R	8/12/97	82.0R	82.0R	8/22/97	76.3M	76.3M	8/29/97	65.0R	65.0R
9/5/97	51.5R	51.5R	9/12/97	58.8R	58.8R	9/26/97	53.9R	53.9R			

LAKE CK. @ HYWY390 DITCH PERMITS: STREAM GAGE DISTRICT: 16

PRIORITY DATES:

SOURCE OF SUPPLY LAKE CREEK, TRIB. FISH CREEK, TRIB. SNAKE RIVER MEAS. DEVICE: STAFF

DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART
10/11/96	12.8R	12.8R	10/25/96	17.7R	17.7R	4/17/97	20.4M	20.4M	4/30/97	50.3R	50.3R
5/8/97	65.1M	1.06G	5/21/97	418R	418R	5/30/97	542R	542R	6/5/97	3.35GH	3.35G
6/10/97	871.8M	871.8	6/18/97	1150E	1150E	6/26/97	305R	305R	7/3/97	220M	220M
7/11/97	282R	282R	7/18/97	197R	197R	7/25/97	173R	173R	7/31/97	135R	135R
8/8/97	90.5R	90.5R	8/12/97	81.2R	81.2R	8/22/97	70.7R	70.7R	8/29/97	56.8R	56.8R
9/5/97	46.7M	46.7M	9/12/97	56.8R	56.8R	9/26/97	54.2R	54.2R			

ARRIVE IS FLOW UPON ARRIVAL AT DITCH DEPART IS FLOW AS LEFT WHEN LEAVING SITE

M = MEASURED FLOW R = RATED FLOW E = ESTIMATED FLOW * = ROTATION INVOLVED

DATA COLLECTED BY: LOREN SMITH, DON BARNEY & CONAN BEESLEY

DATA COMPILED BY: LOREN SMITH

LAKE CK. BL. GRANITE DITCH PERMITS: STREAM GAGE DISTRICT: 16
PRIORITY DATES:
SOURCE OF SUPPLY LAKE CREEK, TRIB. FISH CREEK, TRIB. SNAKE RIVER MEAS. DEVICE: 3.33'STAFF

DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART
10/11/96	28.5R	28.5R	10/25/96	31.4R	31.4R	4/17/97	31.4M	31.4M	4/30/97	48.7R	48.7R
5/8/97	57.7R	1.08G	5/21/97	244R	244R	5/30/97	298R	298R	6/5/97	603M	603M
6/10/97	350E	350E	6/18/97	1110R	1110R	6/26/97	278M	278M	7/3/97	181R	181R
7/11/97	224R	224R	7/18/97	170.2R	170.2	7/25/97	102R	102R	7/31/97	121R	121R
8/8/97	75.4R	75.4R	8/12/97	60.3M	60.3M	8/22/97	54.6R	54.6R	8/29/97	29.2R	29.2R
9/5/97	30.7R	30.7R	9/12/97	44.7R	44.7R	9/26/97	31.0M	31.0M			

LAKE CK. ABV. GRANIT DITCH PERMITS: STREAM GAGE DISTRICT: 16
PRIORITY DATES:
SOURCE OF SUPPLY LAKE CREEK, TRIB. FISH CREEK, TRIB. SNAKE RIVER MEAS. DEVICE: 3.33'STAFF

DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART	DATE	ARRIVE	DEPART
10/11/96	28.3R	28.3R	10/25/96	30.0R	30.0R	4/17/97	34.6M	34.6M	4/30/97	31.1R	31.1R
5/8/97	31.1R	0.91G	5/21/97	227R	227R	5/30/97	200R	200R	6/5/97	312M	312M
6/10/97	500E	500E	6/18/97	424R	424R	6/26/97	259R	259R	7/3/97	124.5M	124.5
7/11/97	110R	110R	7/18/97	74.6R	74.6R	7/25/97	103R	103R	7/31/97	42.3R	42.3R
8/8/97	23.5R	23.5R	8/12/97	17.0R	17.0R	8/22/97	20.1R	20.1R	8/29/97	18.6R	18.6R
9/5/97	8.9M	8.9M	9/12/97	16.3R	16.3R	9/26/97	8.6R	8.6R			

ARRIVE IS FLOW UPON ARRIVAL AT DITCH DEPART IS FLOW AS LEFT WHEN LEAVING SITE
M = MEASURED FLOW R = RATED FLOW E = ESTIMATED FLOW * = ROTATION INVOLVED

DATA COLLECTED BY: LOREN SMITH, DON BARNEY & CONAN BEESLEY
DATA COMPILED BY: LOREN SMITH

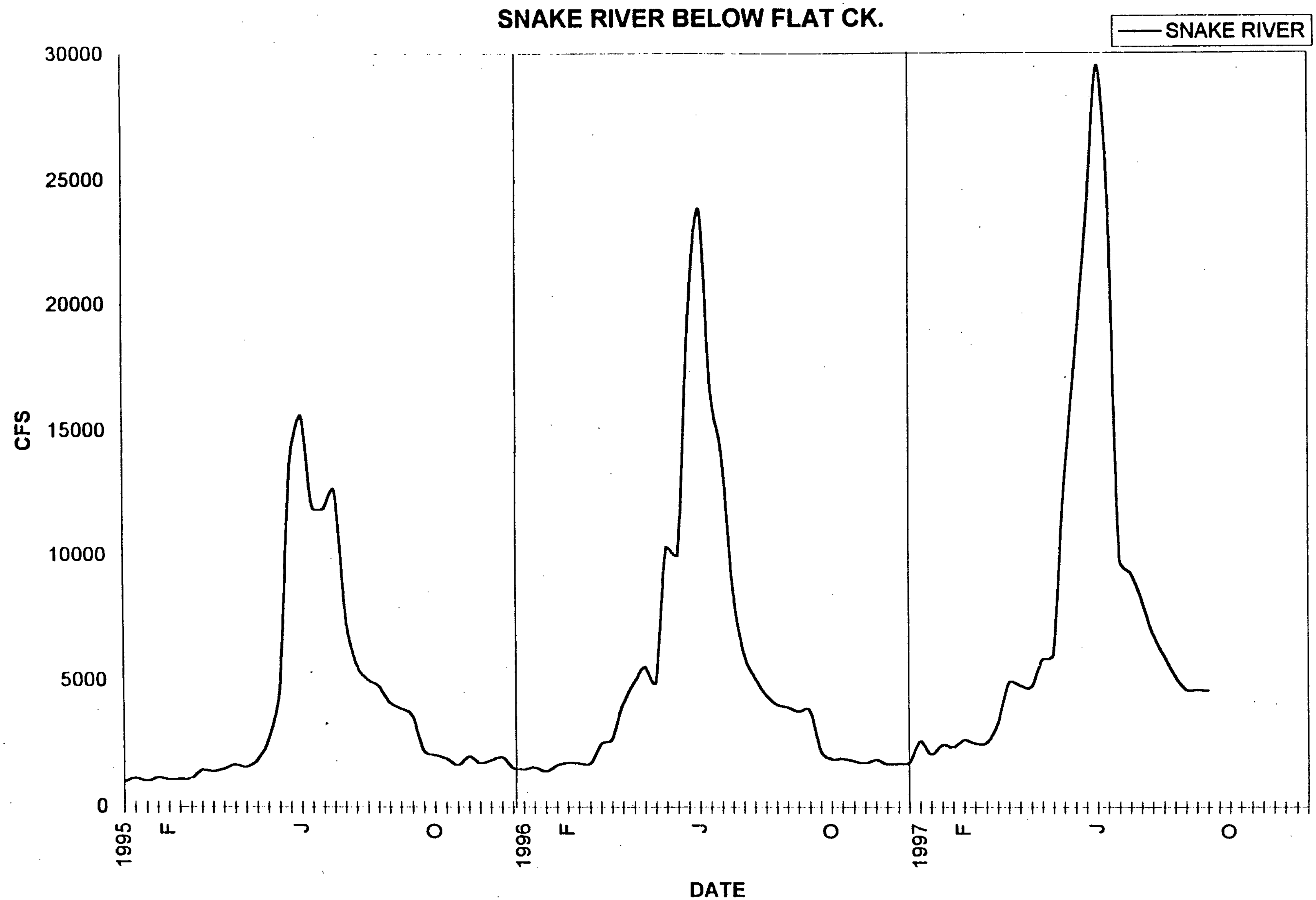
PART VI. SURFACE WATER DATA

b) Hydrographer Annual Report

1. Stream & Diversion Hydrographs

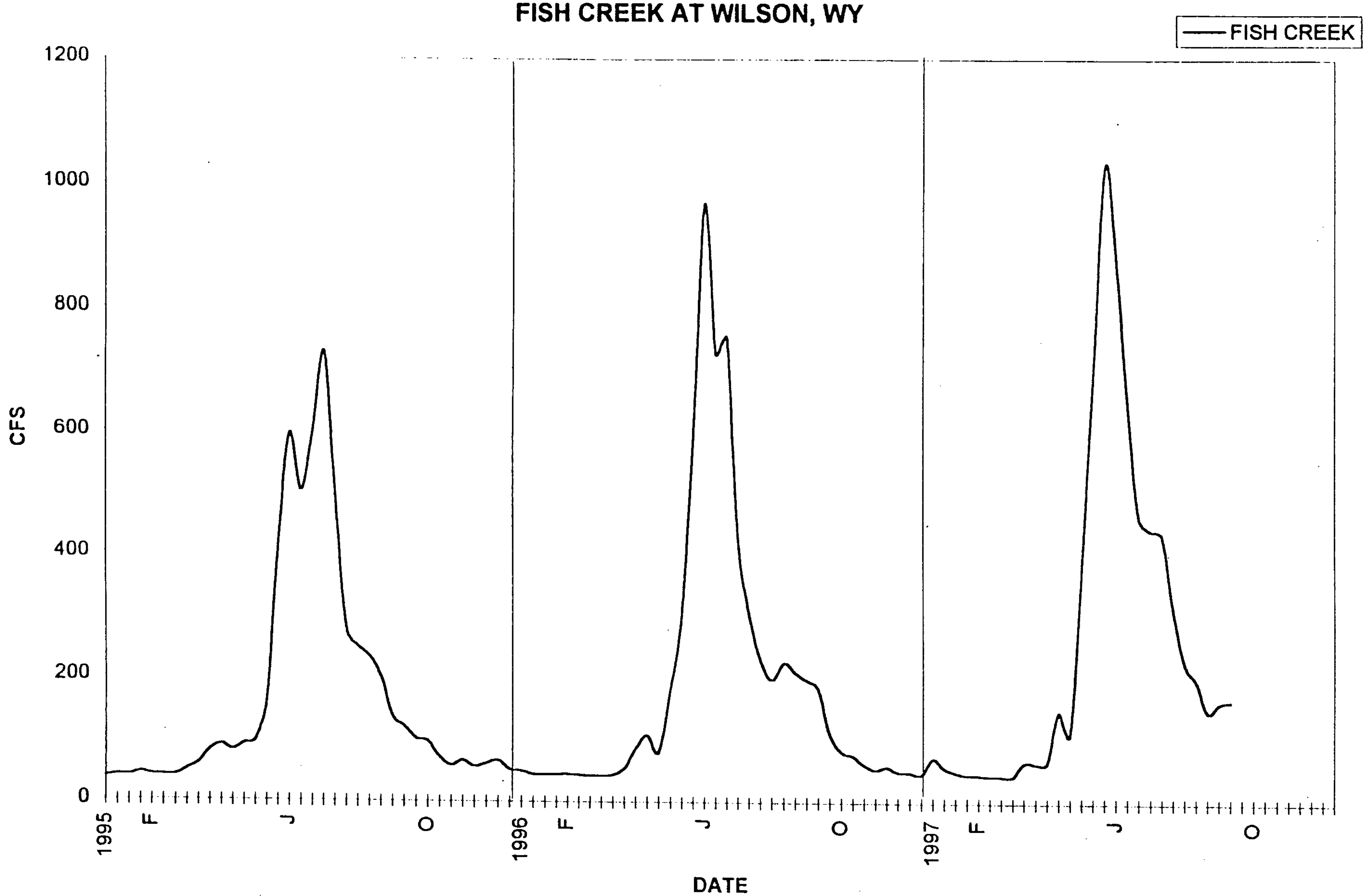
95 - 97

SNAKE

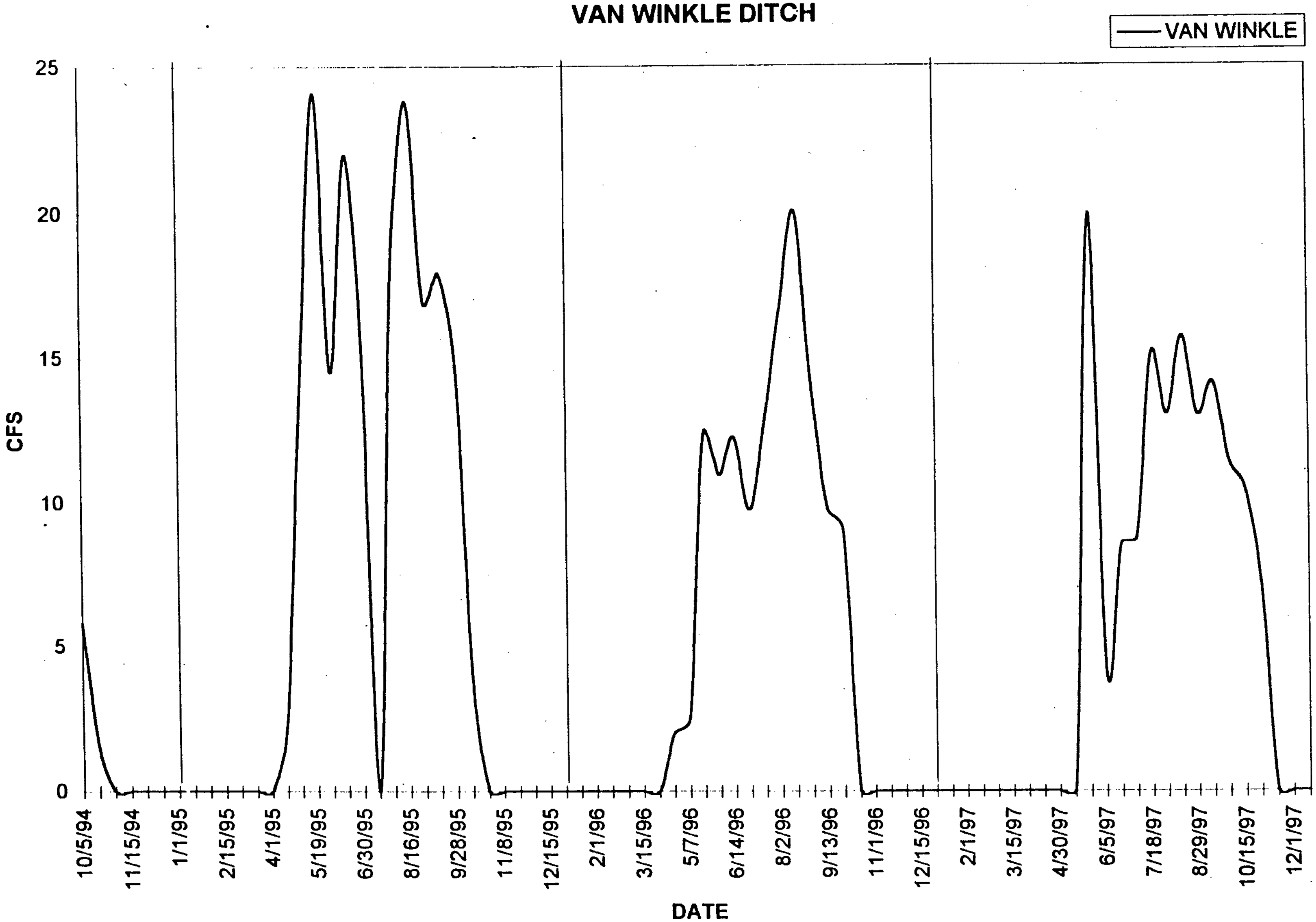


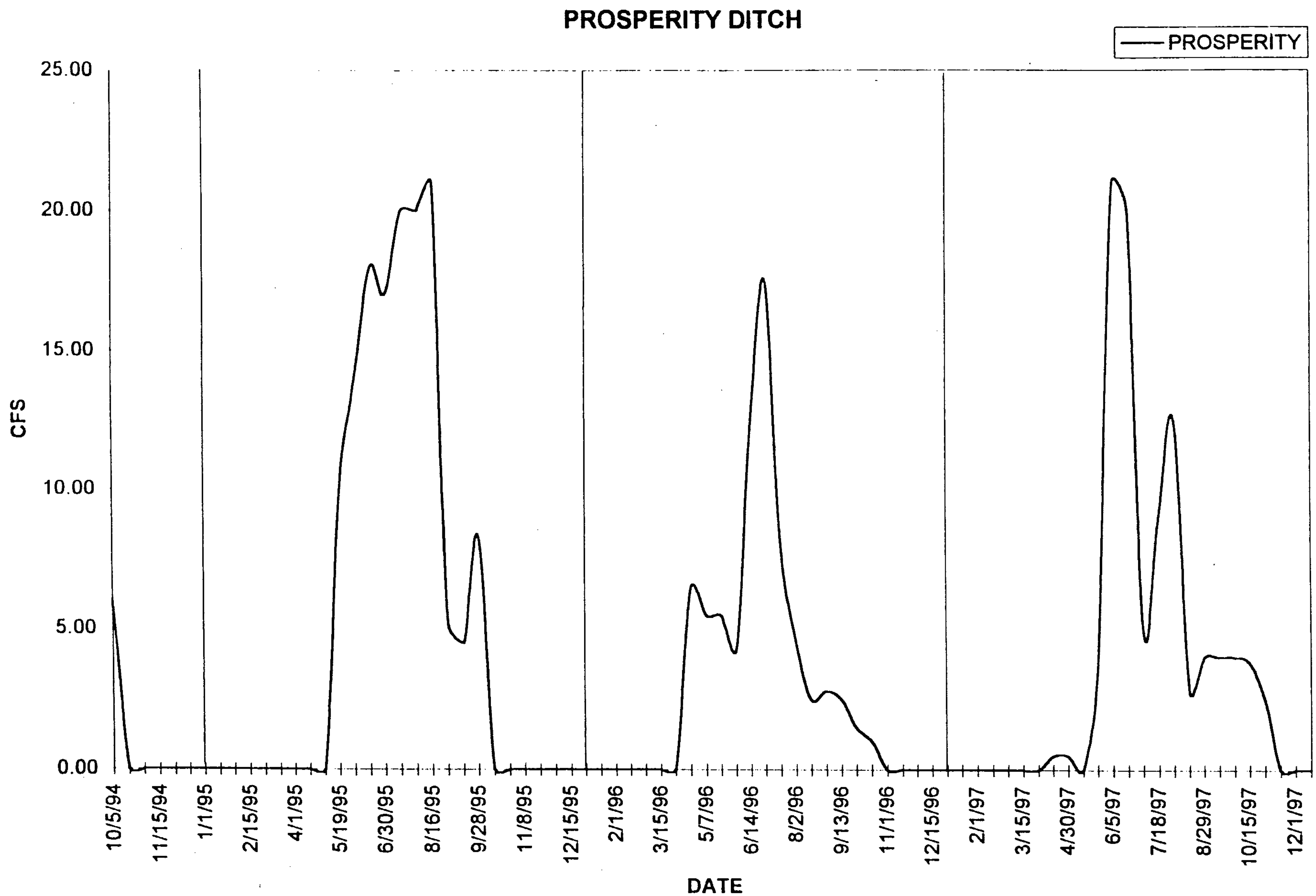
SNAKE RIVER BELOW FLAT CK.
SNAKE RIVER
CFS
30000
25000
20000
15000
10000
5000
0
1995
F
J
O
1996
F
J
O
1997
F
J
O
DATE

FISH CREEK AT WILSON, WY



VAN WINKLE DITCH




PROSPERITY DITCH
PROSPERITY
CFS
25.00
20.00
15.00
10.00
5.00
0.00
10/5/94
11/15/94
1/1/95
2/15/95
4/1/95
5/19/95
6/30/95
8/16/95
9/28/95
11/8/95
12/15/95
2/1/96
3/15/96
5/7/96
6/14/96
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9/13/96
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12/15/96
2/1/97
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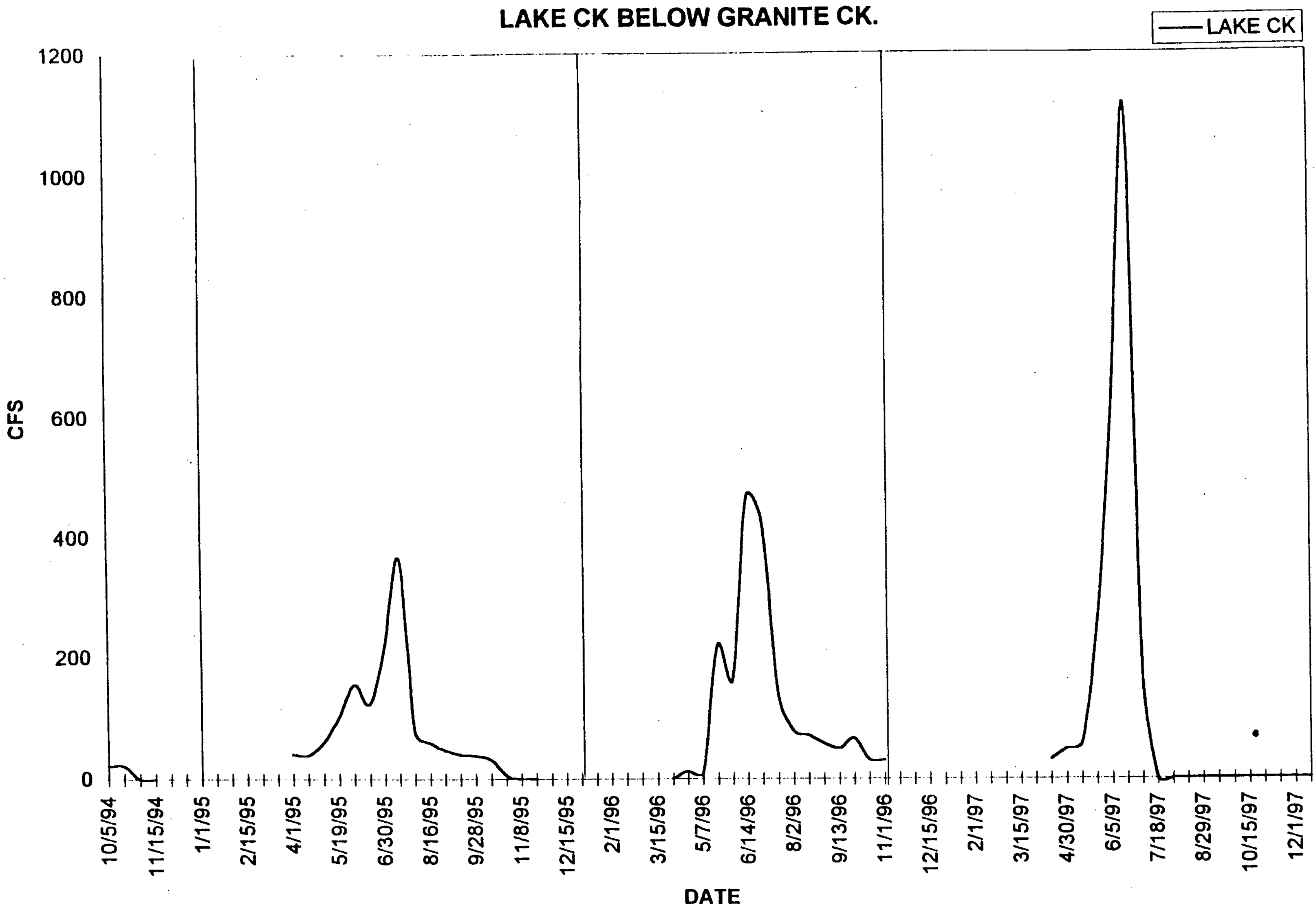
4/30/97
6/5/97
7/18/97
8/29/97
10/15/97
12/1/97
DATE


LAKE CK BELOW GRANITE CK.
LAKE CK
CFS
1200
1000
800
600
400
200
0
10/5/94
11/15/94
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2/15/95
4/1/95
5/19/95
6/30/95
8/16/95
9/28/95
11/8/95
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9/13/96
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12/15/96
2/1/97
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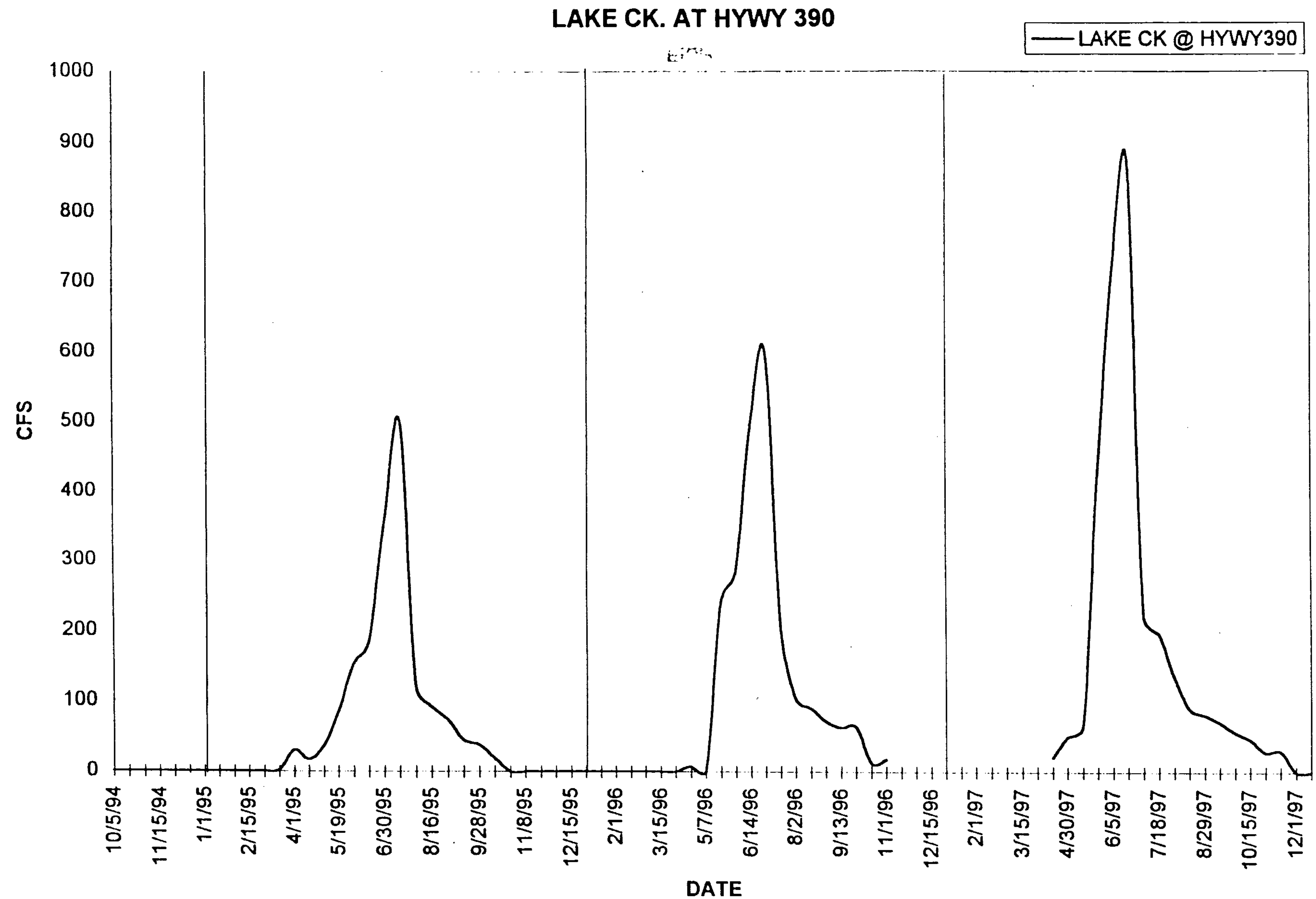
4/30/97
6/5/97
7/18/97
8/29/97
10/15/97
12/1/97
DATE


LAKE CK. AT HYWY 390
LAKE CK @ HYWY390
CFS
1000
900
800
700
600
500
400
300
200
100
0
10/5/94
11/15/94
1/1/95
2/15/95
4/1/95
5/19/95
6/30/95
8/16/95
9/28/95
11/8/95
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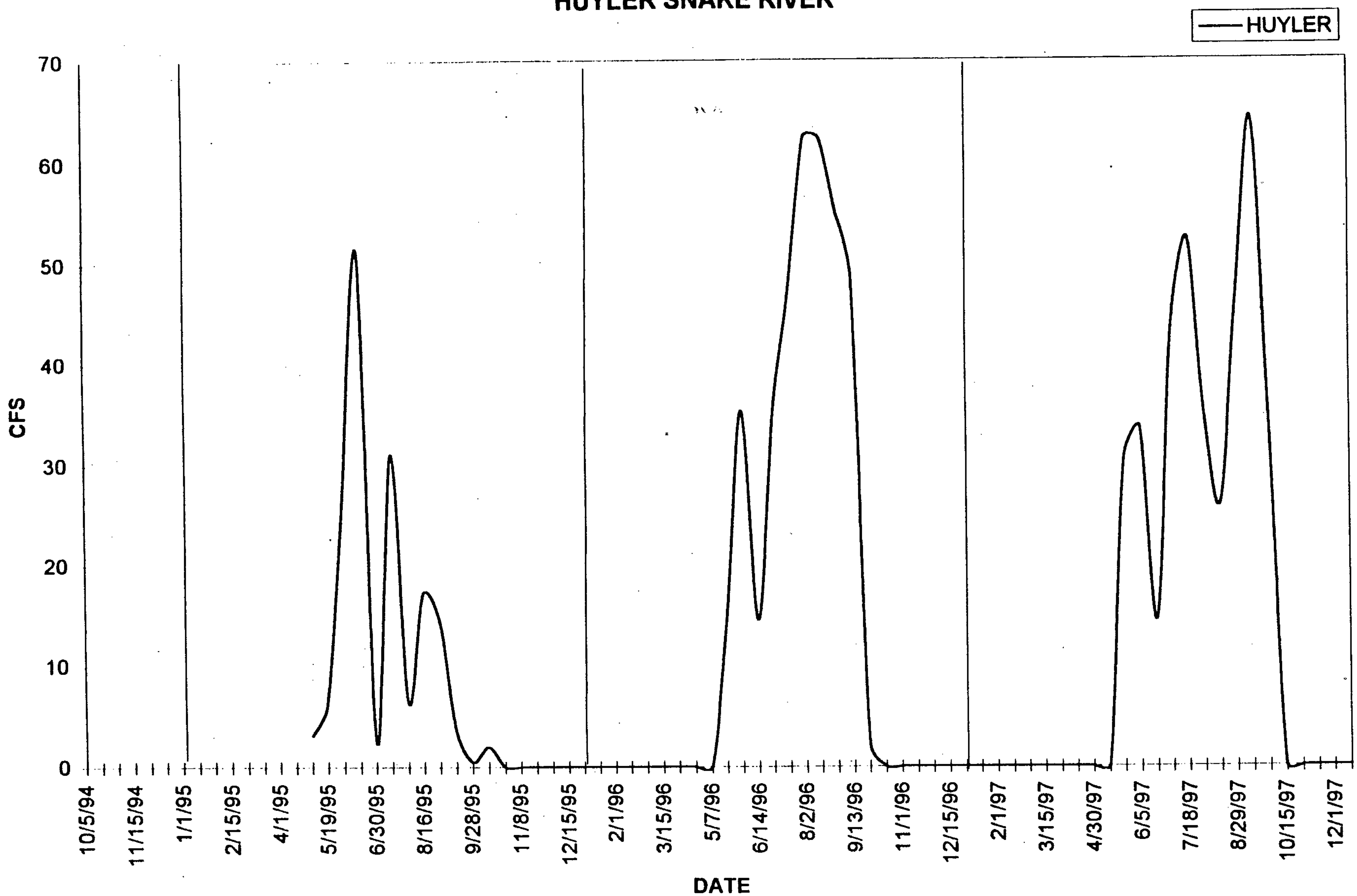
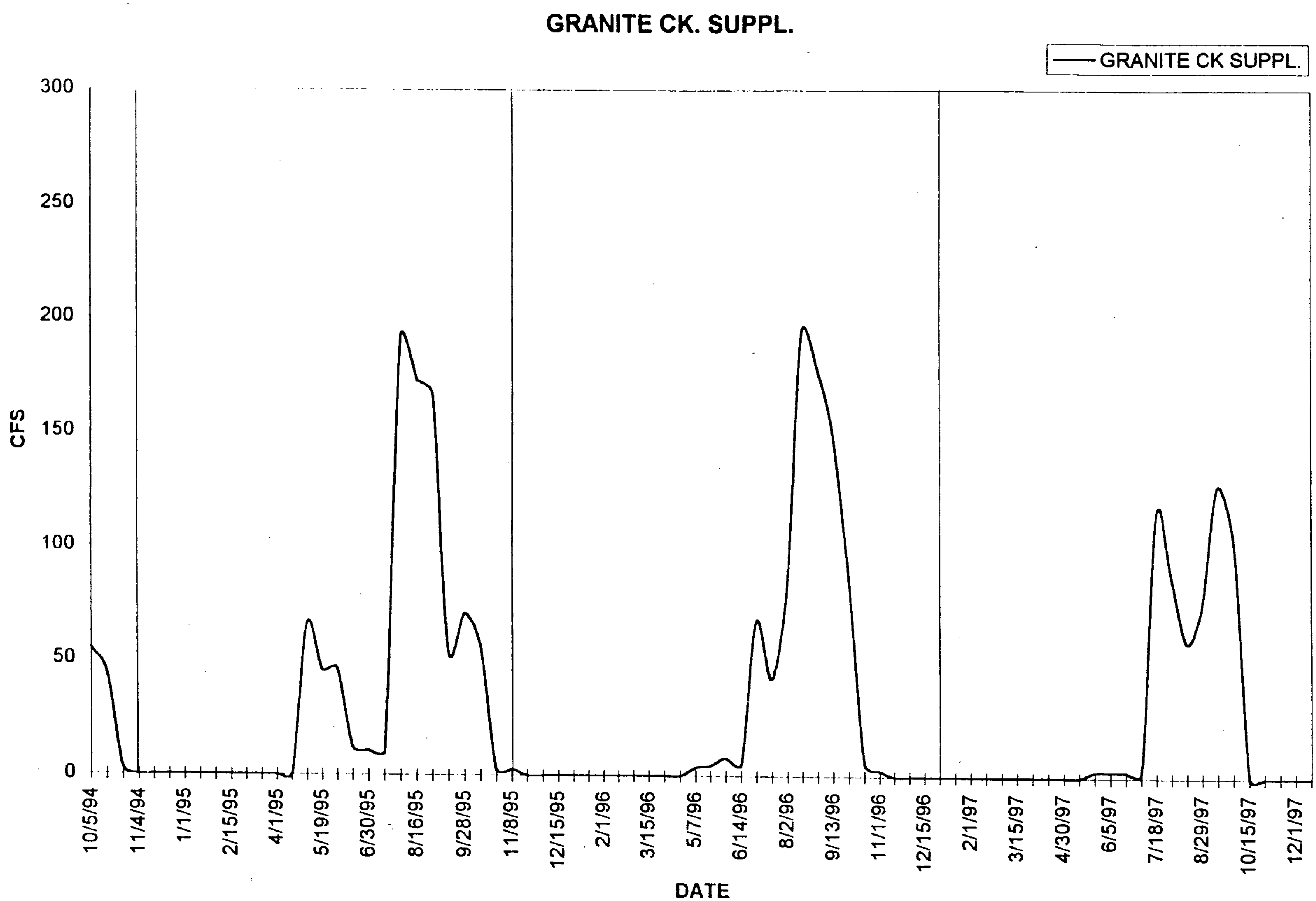
5/7/96
6/14/96
8/2/96
9/13/96
11/1/96
12/15/96
2/1/97
3/15/97
4/30/97
6/5/97
7/18/97
8/29/97
10/15/97
12/1/97
DATE

HUYLER SNAKE RIVER




GRANITE CK. SUPPL.
GRANITE CK SUPPL.
300
250
200
150
100
50
0
CFS
10/5/94
11/4/94
1/1/95
2/15/95
4/1/95
5/19/95
6/30/95
8/16/95
9/28/95
11/8/95
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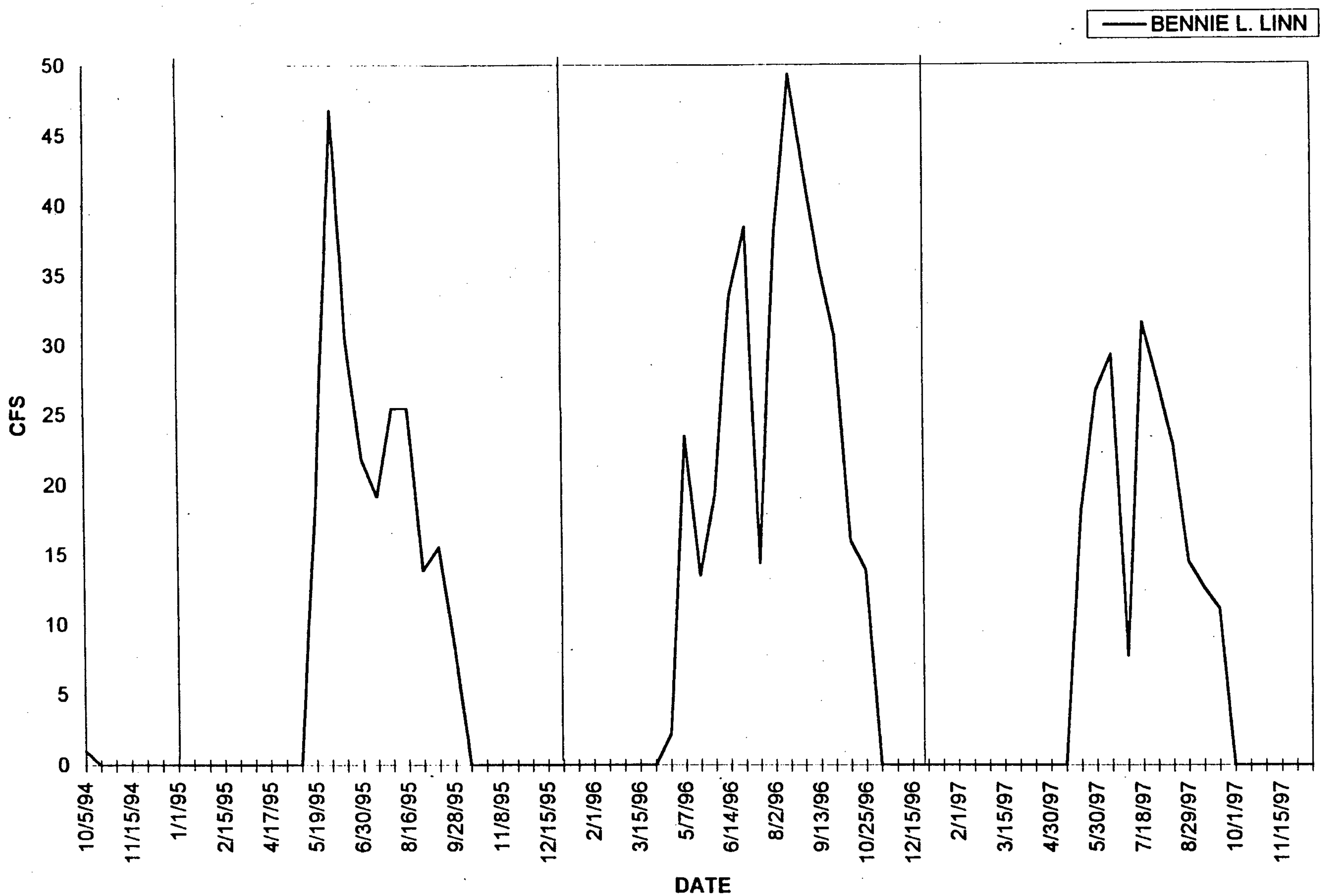
12/15/96
2/1/97
3/15/97
4/30/97
6/5/97
7/18/97
8/29/97
10/15/97
12/1/97
DATE

BL

BENNIE LINN DITCH



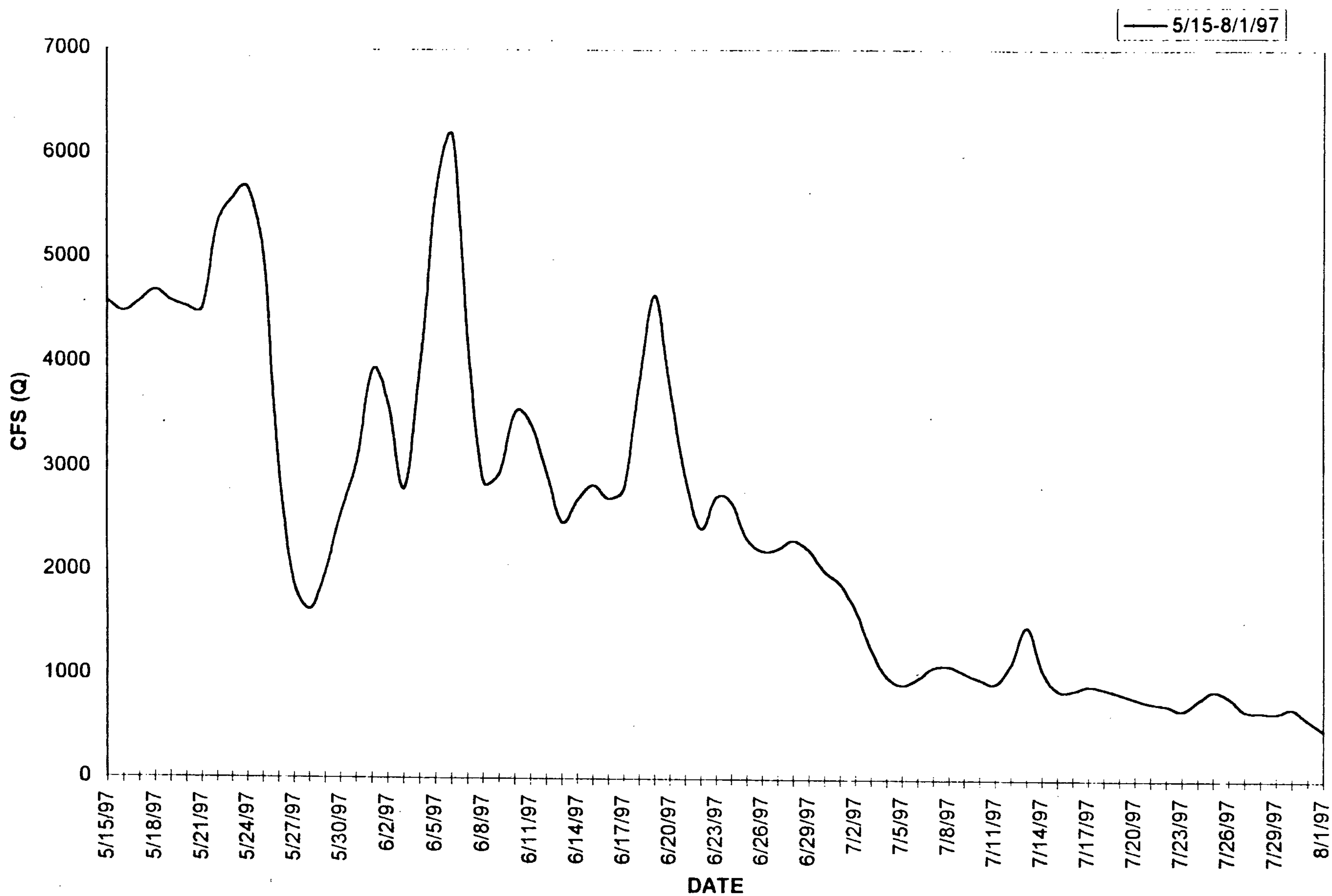
PART VII. GROUND WATER OBSERVATION vs SNAKE RIVER FLOWS

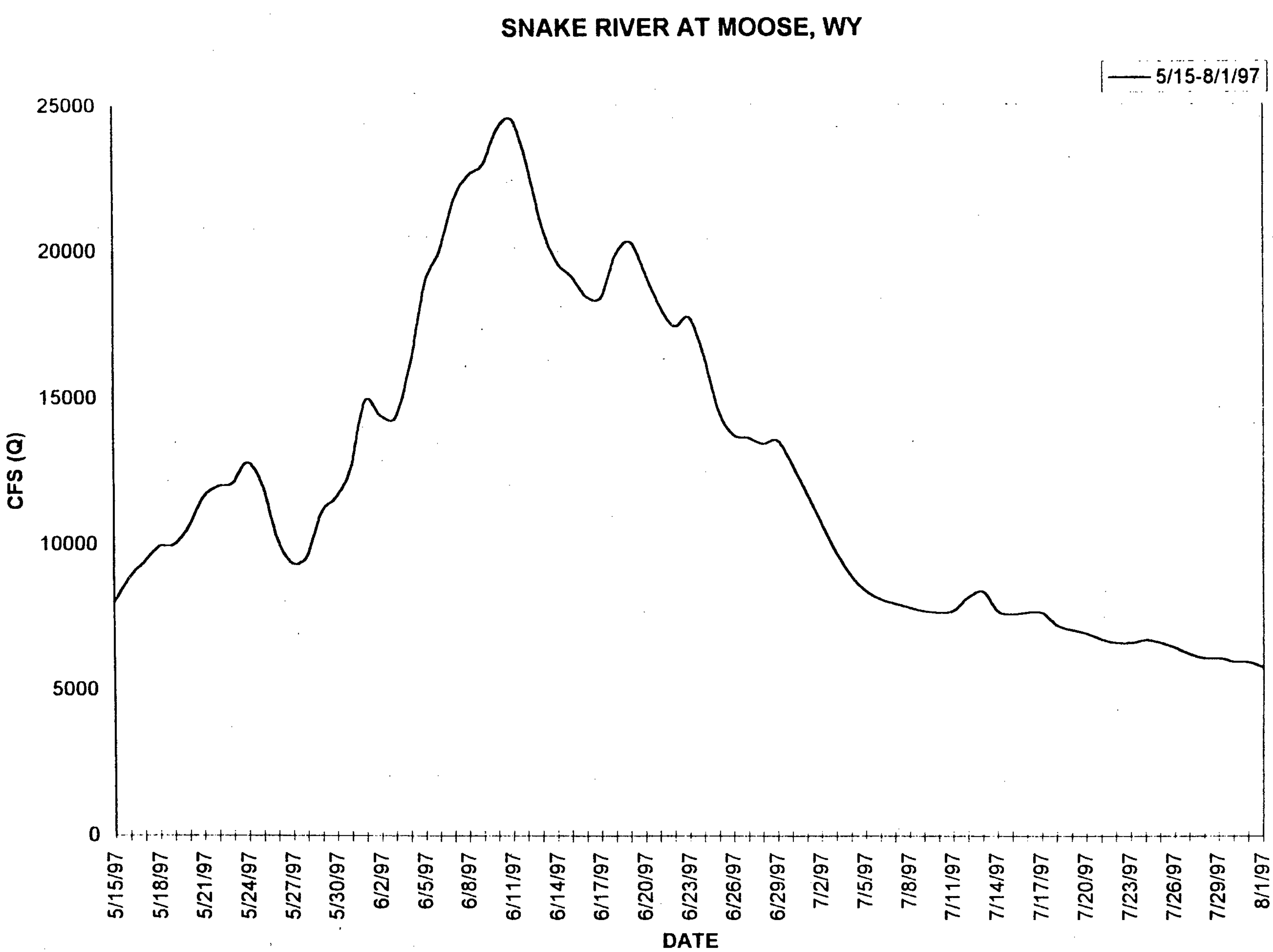
a) Hydrography Comparison

1. Surface Water Hydrography

FISH CREEK AT WILSON, WY

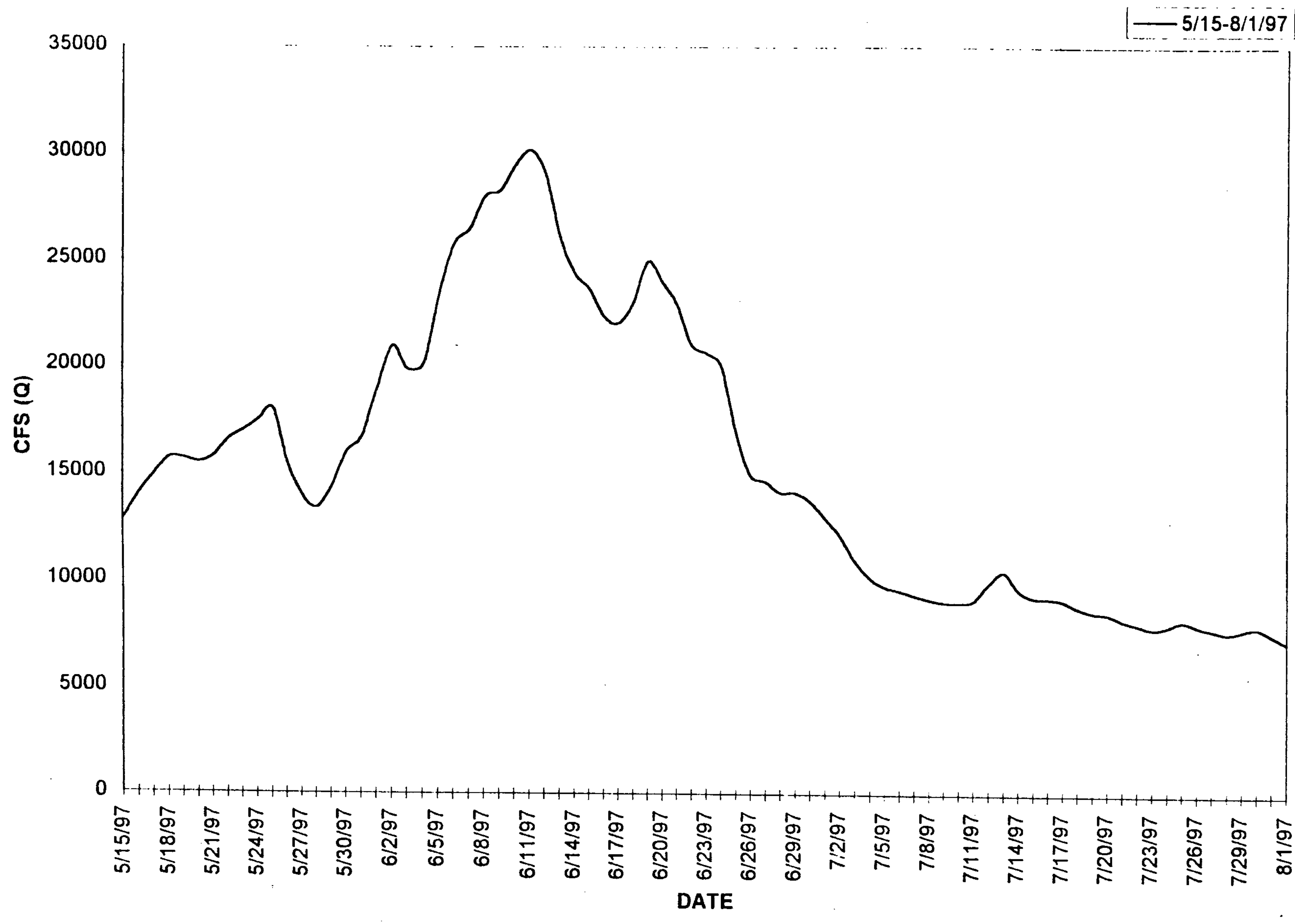
GROS VENTRE RIVER NEAR ZENITH, WY





SNAKE RIVER AT MOOSE, WY
5/15-8/1/97
CFS (Q)
25000
20000
15000
10000
5000
0
5/15/97
5/18/97
5/21/97
5/24/97
5/27/97
5/30/97
6/2/97
6/5/97
6/8/97
6/11/97
6/14/97
6/17/97
6/20/97
6/23/97
6/26/97
6/29/97
7/2/97
7/5/97
7/8/97
7/11/97
7/14/97
7/17/97
7/20/97
7/23/97
7/26/97
7/29/97
8/1/97
DATE

SNAKE RIVER BELOW FLAT CREEK



snake river BEL		fish @		gros ventre	
date	cfs	date	cfs	date	cfs
5/15/97	12800	5/15/97	368	5/15/97	4590
5/16/97	14000	5/16/97	429	5/16/97	4490
5/17/97	14900	5/17/97	446	5/17/97	4590
5/18/97	15700	5/18/97	504	5/18/97	4700
5/19/97	15700	5/19/97	533	5/19/97	4600
5/20/97	15500	5/20/97	536	5/20/97	4540
5/21/97	15800	5/21/97	567	5/21/97	4520
5/22/97	16600	5/22/97	597	5/22/97	5340
5/23/97	17000	5/23/97	622	5/23/97	5580
5/24/97	17500	5/24/97	722	5/24/97	5680
5/25/97	18000	5/25/97	686	5/25/97	5040
5/26/97	15500	5/26/97	590	5/26/97	3010
5/27/97	14000	5/27/97	519	5/27/97	1870
5/28/97	13400	5/28/97	457	5/28/97	1630
5/29/97	14400	5/29/97	536	5/29/97	1970
5/30/97	16000	5/30/97	638	5/30/97	2540
5/31/97	16700	5/31/97	704	5/31/97	3050
6/1/97	18900	6/1/97	834	6/1/97	3930
6/2/97	21000	6/2/97	967	6/2/97	3600
6/3/97	19900	6/3/97	950	6/3/97	2790
6/4/97	20100	6/4/97	942	6/4/97	4000
6/5/97	23400	6/5/97	1030	6/5/97	5680
6/6/97	25800	6/6/97	1090	6/6/97	6170
6/7/97	26500	6/7/97	1140	6/7/97	4120
6/8/97	28000	6/8/97	1270	6/8/97	2860
6/9/97	28300	6/9/97	1350	6/9/97	2950
6/10/97	29500	6/10/97	1350	6/10/97	3530
6/11/97	30200	6/11/97	1260	6/11/97	3410
6/12/97	29100	6/12/97	1170	6/12/97	2950
6/13/97	26100	6/13/97	1050	6/13/97	2470
6/14/97	24400	6/14/97	934	6/14/97	2690
6/15/97	23700	6/15/97	873	6/15/97	2830
6/16/97	22400	6/16/97	853	6/16/97	2700
6/17/97	22100	6/17/97	886	6/17/97	2800
6/18/97	23100	6/18/97	1080	6/18/97	3820
6/19/97	25000	6/19/97	1180	6/19/97	4640
6/20/97	24000	6/20/97	1160	6/20/97	3750
6/21/97	23000	6/21/97	1050	6/21/97	2910
6/22/97	21100	6/22/97	927	6/22/97	2410
6/23/97	20700	6/23/97	885	6/23/97	2720
6/24/97	20100	6/24/97	780	6/24/97	2670
6/25/97	17000	6/25/97	644	6/25/97	2320
6/26/97	15000	6/26/97	609	6/26/97	2200
6/27/97	14700	6/27/97	630	6/27/97	2220
6/28/97	14200	6/28/97	665	6/28/97	2300
6/29/97	14200	6/29/97	653	6/29/97	2210
6/30/97	13800	6/30/97	642	6/30/97	2010
7/1/97	13000	7/1/97	615	7/1/97	1890
7/2/97	12200	7/2/97	574	7/2/97	1640

7/3/97	11000	7/3/97	506	7/3/97	1260
7/4/97	10200	7/4/97	435	7/4/97	1000
7/5/97	9800	7/5/97	462	7/5/97	923
7/6/97	9600	7/6/97	495	7/6/97	985
7/7/97	9400	7/7/97	532	7/7/97	1090
7/8/97	9210	7/8/97	532	7/8/97	1100
7/9/97	9090	7/9/97	526	7/9/97	1040
7/10/97	9060	7/10/97	544	7/10/97	977
7/11/97	9150	7/11/97	558	7/11/97	936
7/12/97	9950	7/12/97	601	7/12/97	1130
7/13/97	10500	7/13/97	558	7/13/97	1480
7/14/97	9660	7/14/97	483	7/14/97	1060
7/15/97	9290	7/15/97	440	7/15/97	874
7/16/97	9280	7/16/97	429	7/16/97	873
7/17/97	9160	7/17/97	442	7/17/97	917
7/18/97	8820	7/18/97	451	7/18/97	890
7/19/97	8610	7/19/97	463	7/19/97	844
7/20/97	8550	7/20/97	477	7/20/97	798
7/21/97	8240	7/21/97	444	7/21/97	755
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7/24/97	7990	7/24/97	424	7/24/97	787
7/25/97	8210	7/25/97	432	7/25/97	876
7/26/97	7970	7/26/97	420	7/26/97	811
7/27/97	7820	7/27/97	406	7/27/97	682
7/28/97	7660	7/28/97	392	7/28/97	673
7/29/97	7790	7/29/97	400	7/29/97	665
7/30/97	7920	7/30/97	388	7/30/97	704
7/31/97	7580	7/31/97	375	7/31/97	595
8/1/97	7210	8/1/97	349	8/1/97	490

snake @ moose

date	cfs
5/15/97	8020
5/16/97	8870
5/17/97	9400
5/18/97	9950
5/19/97	10000
5/20/97	10600
5/21/97	11600
5/22/97	12000
5/23/97	12100
5/24/97	12800
5/25/97	12000
5/26/97	10200
5/27/97	9340
5/28/97	9570
5/29/97	11100
5/30/97	11600
5/31/97	12600
6/1/97	14900
6/2/97	14400
6/3/97	14300
6/4/97	16100
6/5/97	18900
6/6/97	20000
6/7/97	21800
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6/17/97	18400
6/18/97	19900
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6/20/97	19200
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6/24/97	16400
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7/2/97	10700

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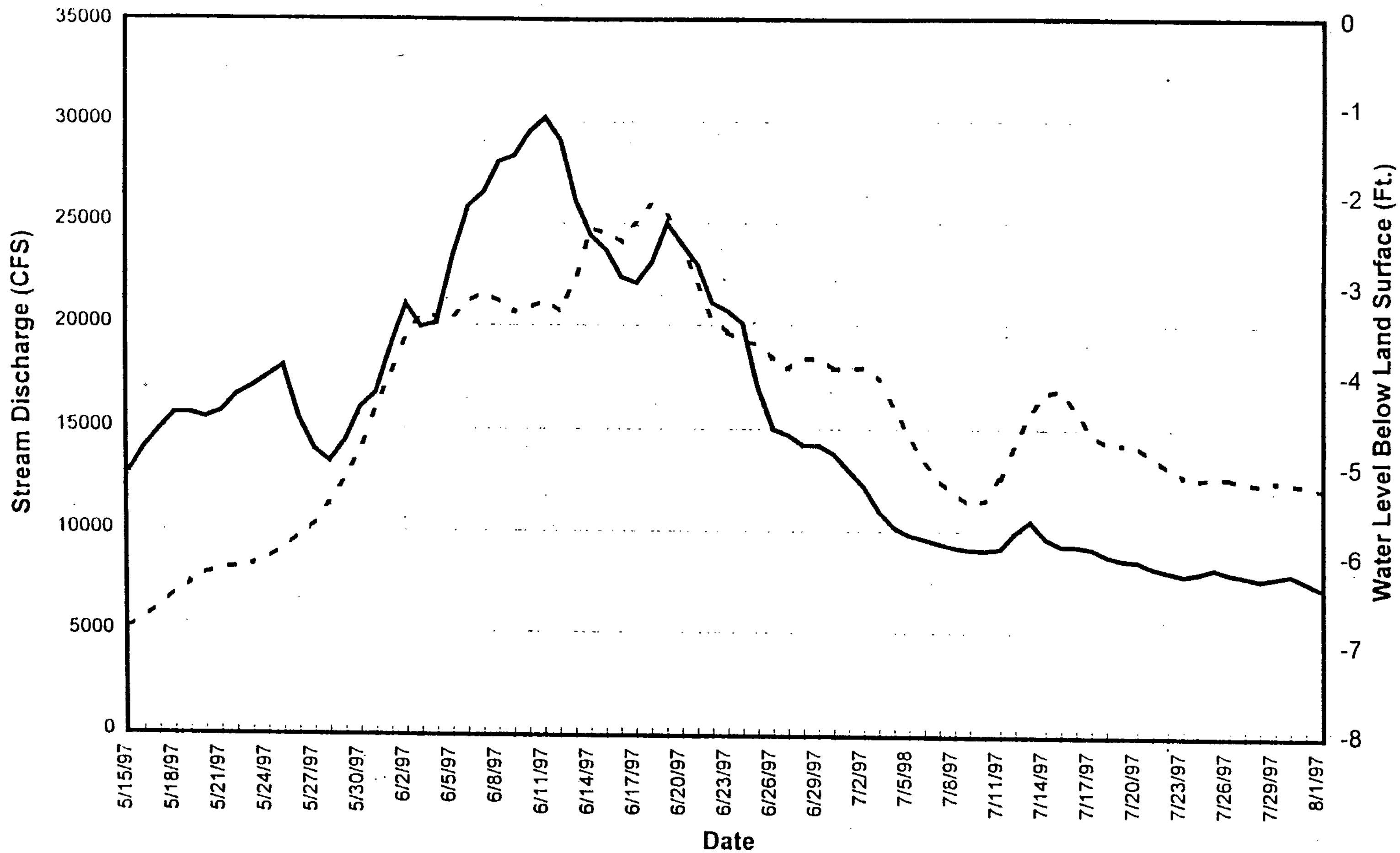
7/29/97	6100
7/30/97	5990
7/31/97	5960
8/1/97	5780

PART VII. GROUND WATER OBSERVATION vs SNAKE RIVER FLOWS

a) Hydrograph Comparisons

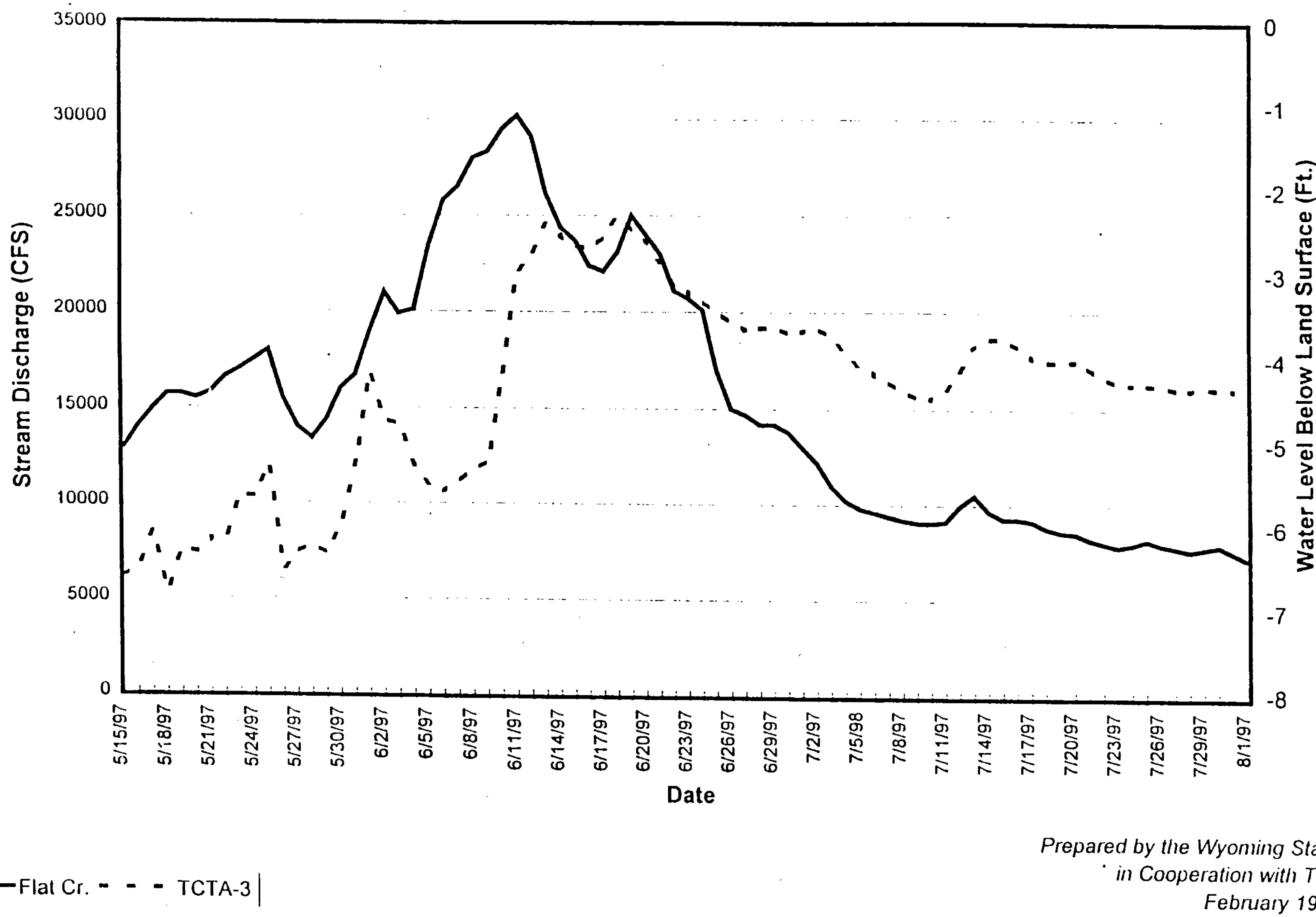
Snake River Discharge -vs- Ground Water Level
Snake River Below Flat Creek
Observation Well TCTA-2



Prepared by the Wyoming State Engineer's Office
in Cooperation with Teton County
February 1999

Pa

Snake River Discharge -vs- Ground Water Level
Snake River Below Flat Creek
Observation Well TCTA-3



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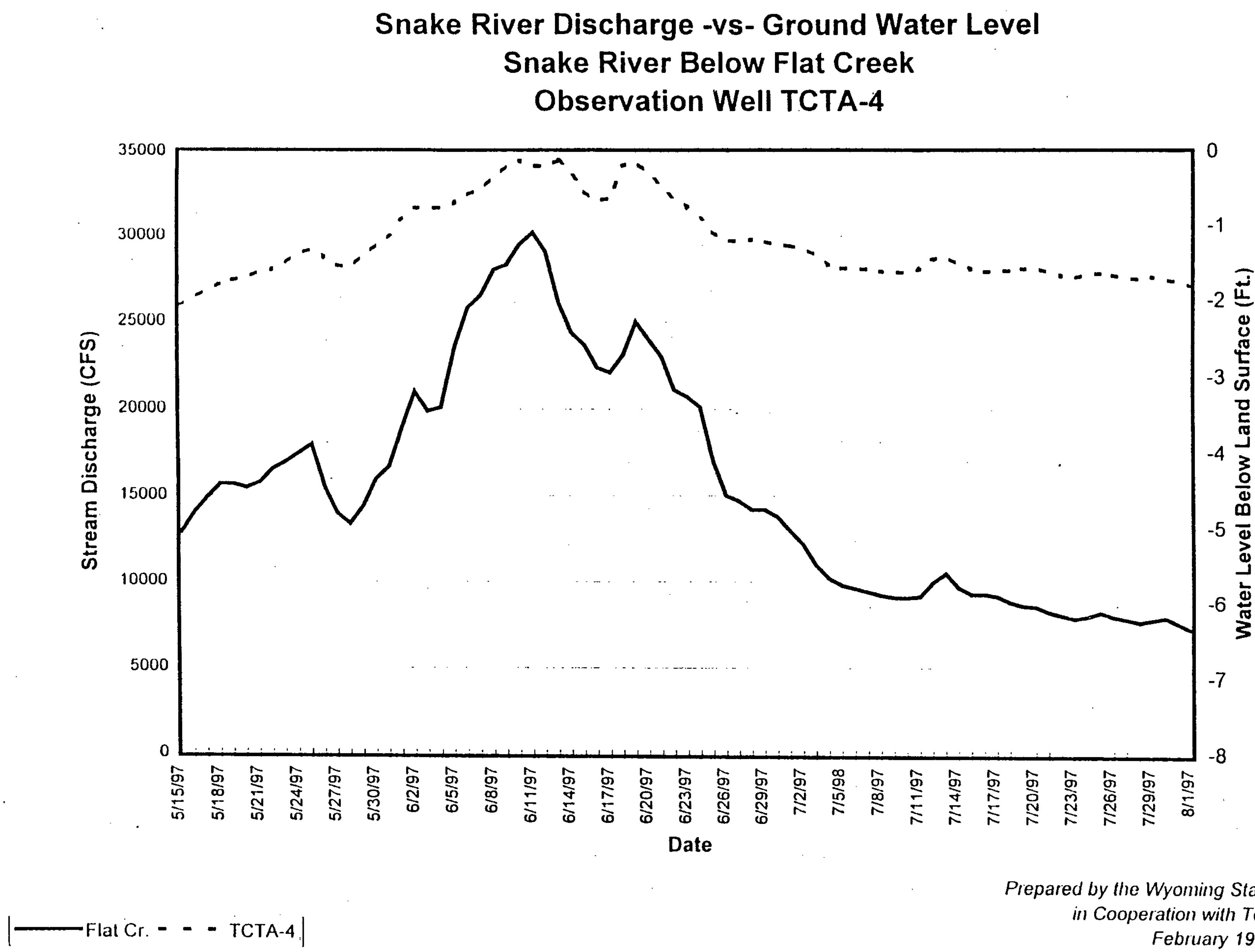
February 1999



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February 1999

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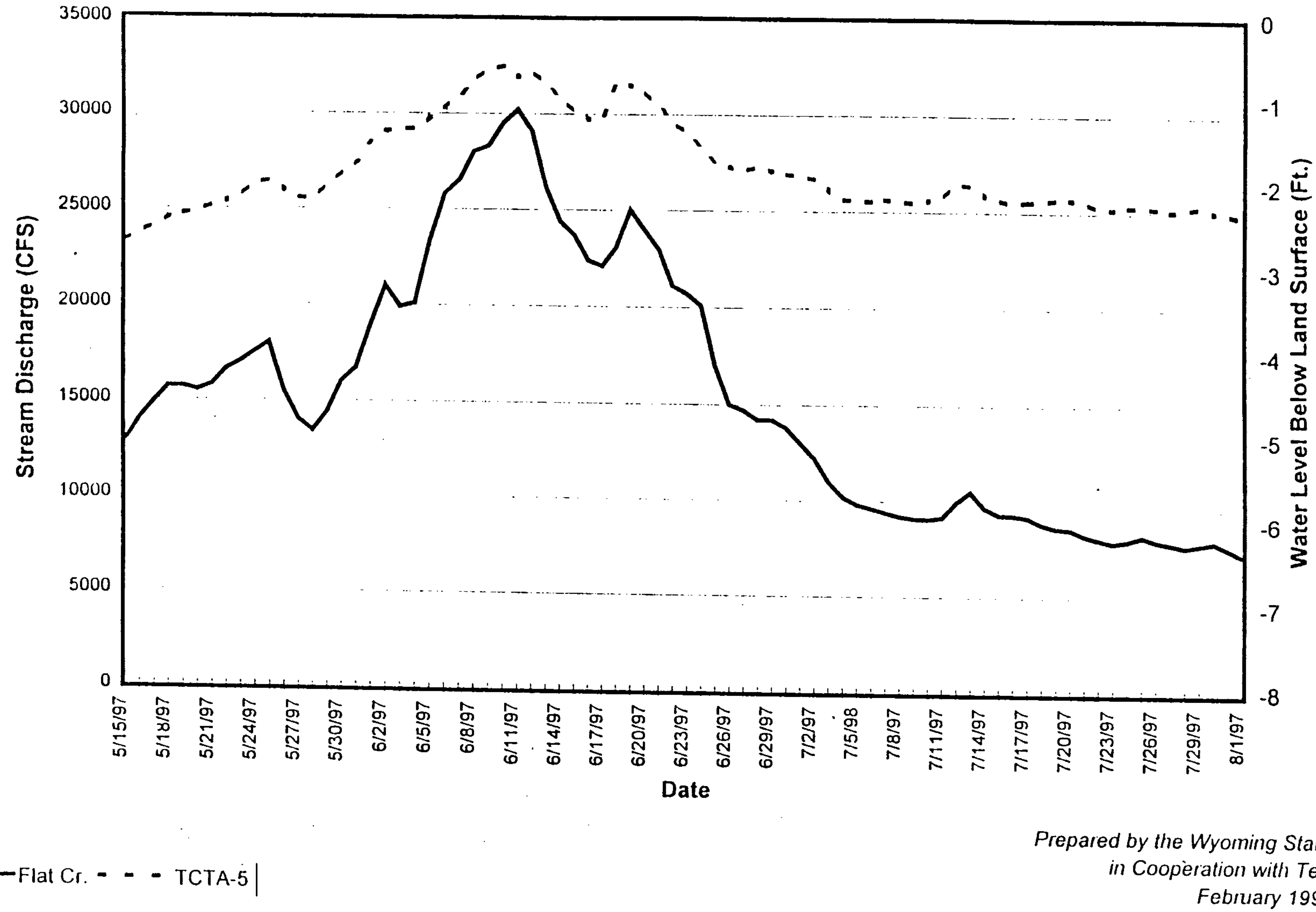
Snake River Discharge -vs- Ground Water Level
Snake River Below Flat Creek
Observation Well TCTA-5



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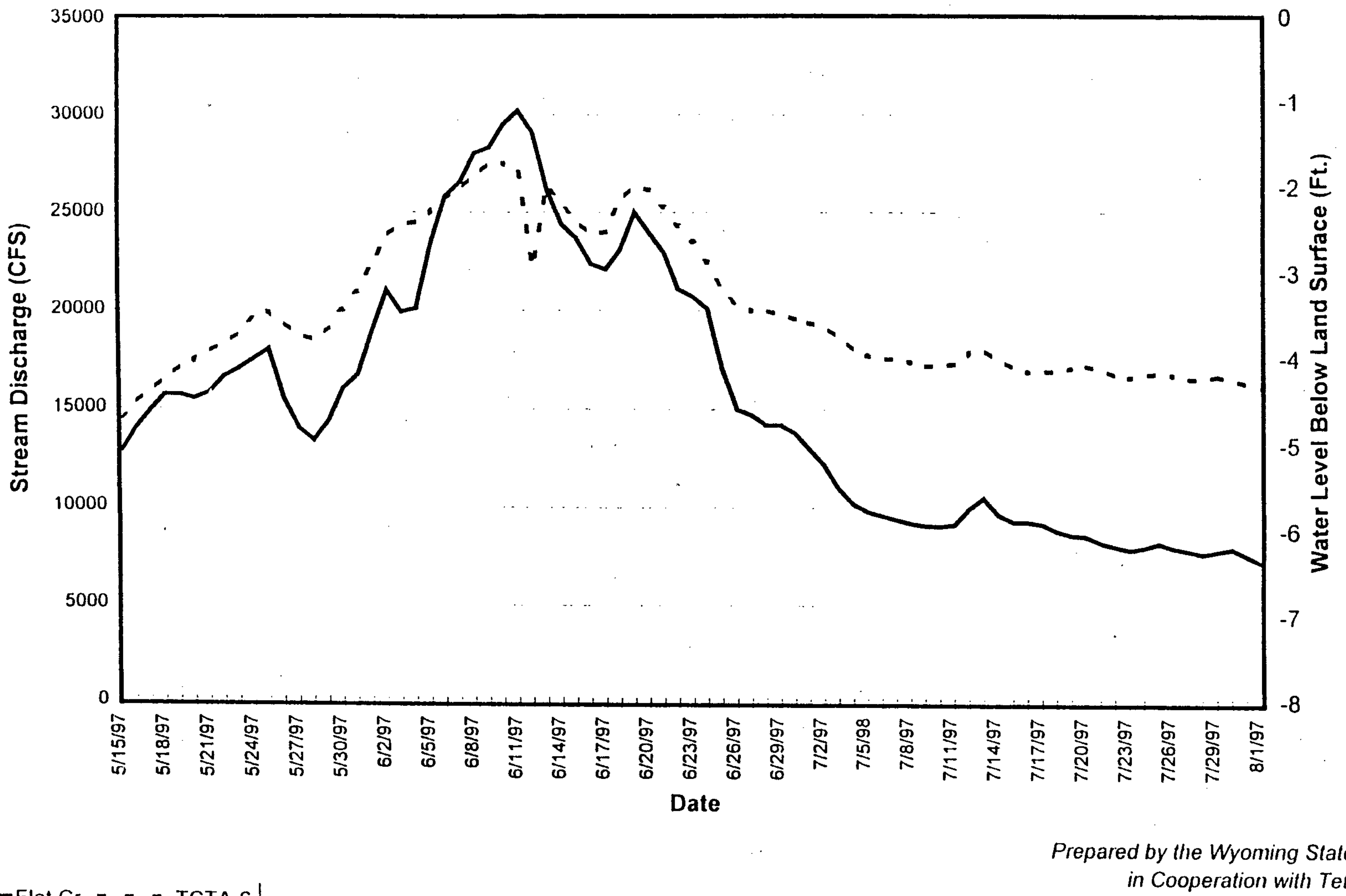
February 1999

Snake River Discharge -vs- Ground Water Level
Snake River Below Flat Creek
Observation Well TCTA-6



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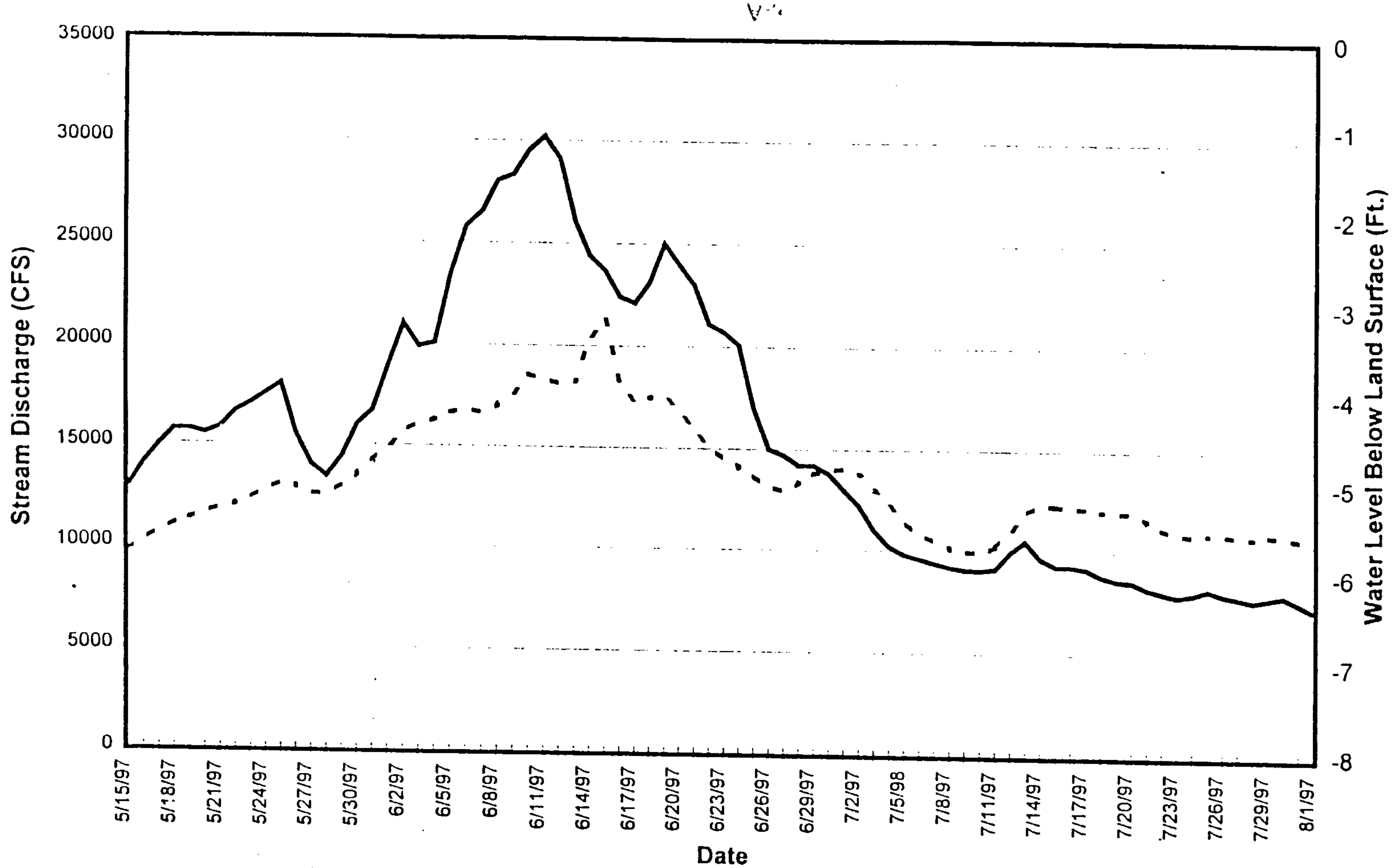
February 1999

Snake River Discharge -vs- Ground Water Level
Snake River Below Flat Creek
Observation Well TCTA-7



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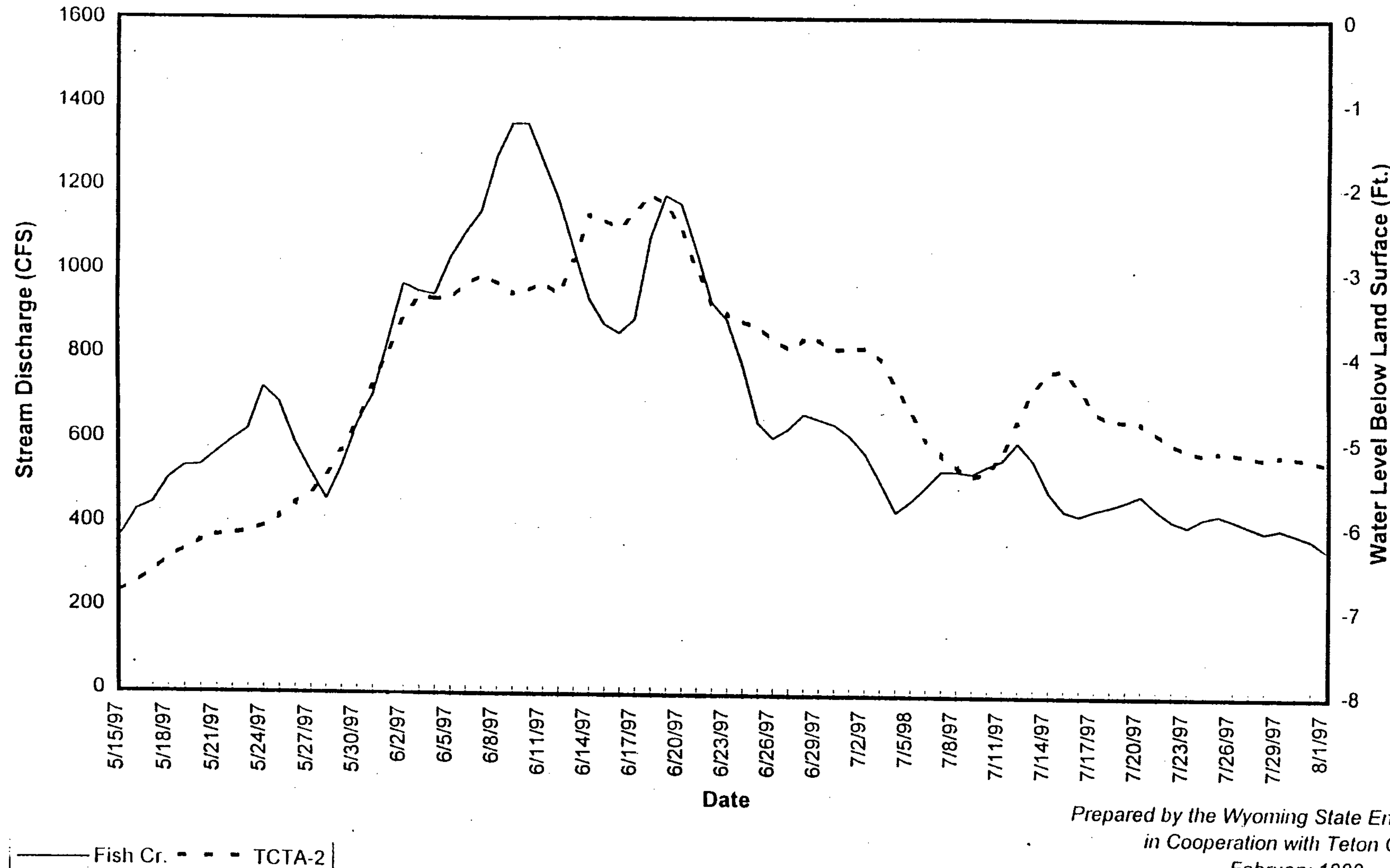
in Cooperation with Teton County
February 1999

Fish Creek Discharge -vs- Ground Water Level
Fish Creek At Wilson
Observation Well TCTA-2



Prepared by the Wyoming State Engineer's Office
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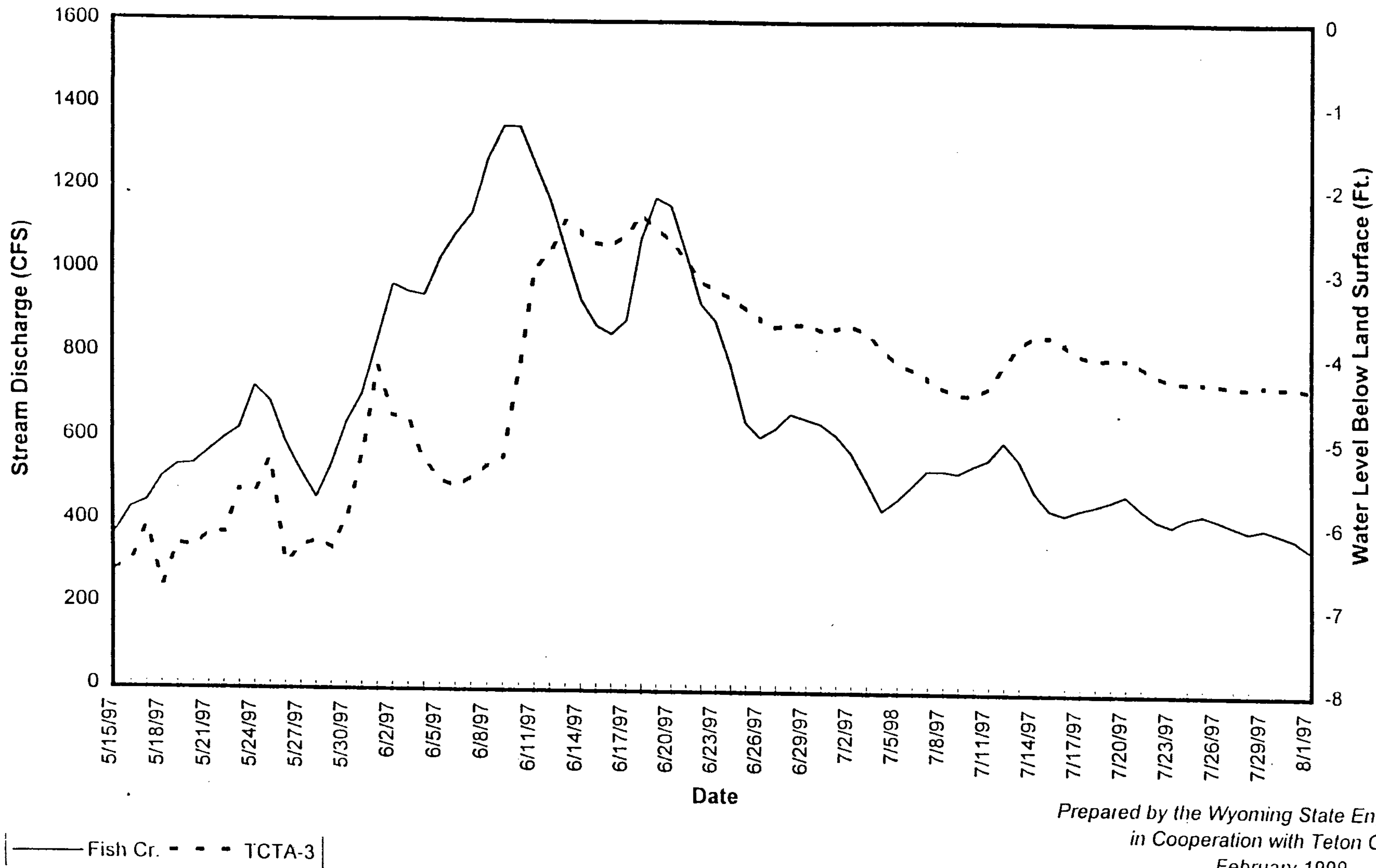
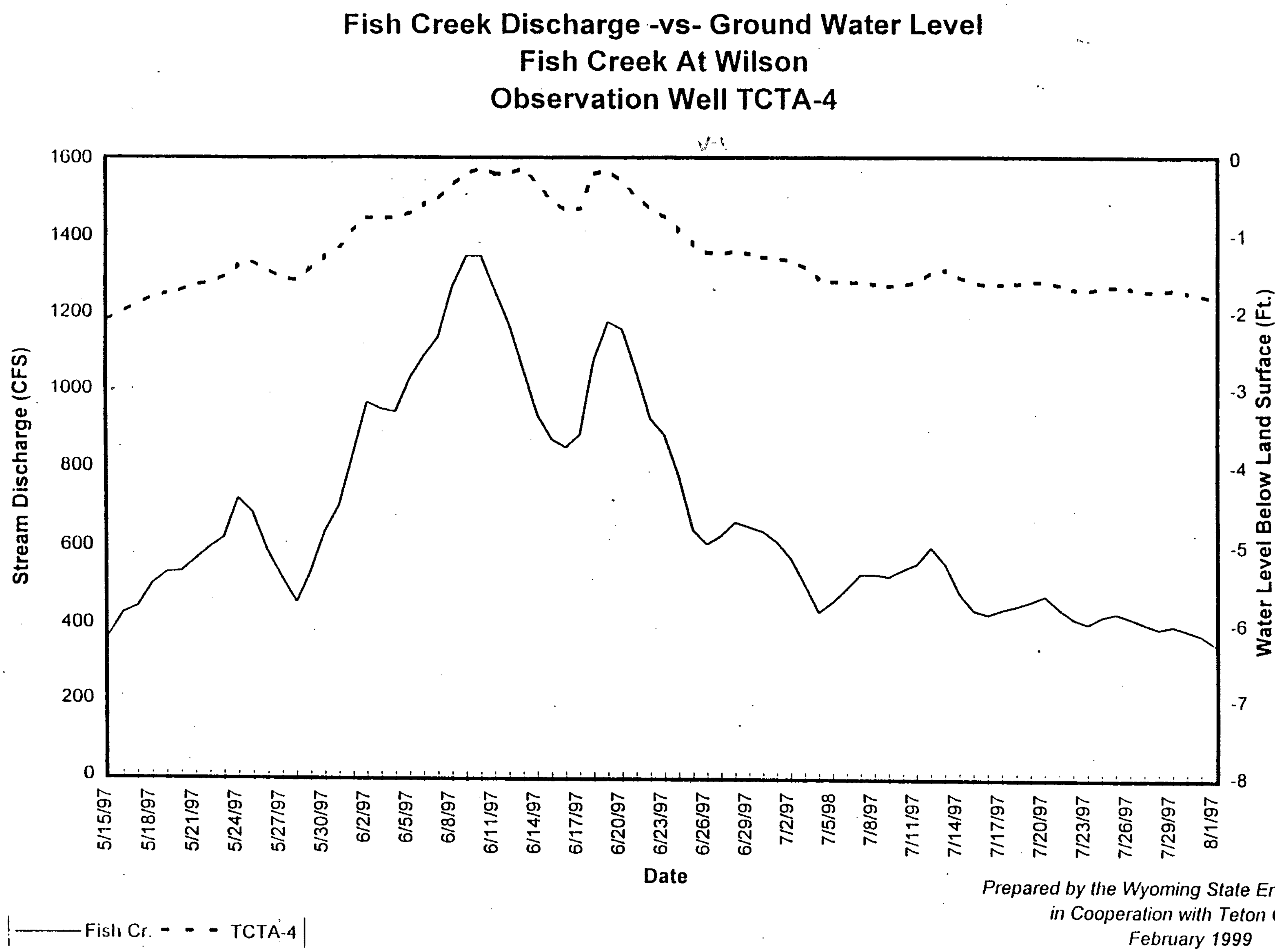
February 1999

P:

Fish Creek Discharge -vs- Ground Water Level
Fish Creek At Wilson
Observation Well TCTA-3



Prepared by the Wyoming State Engineer's Office
in Cooperation with Teton County
February 1999



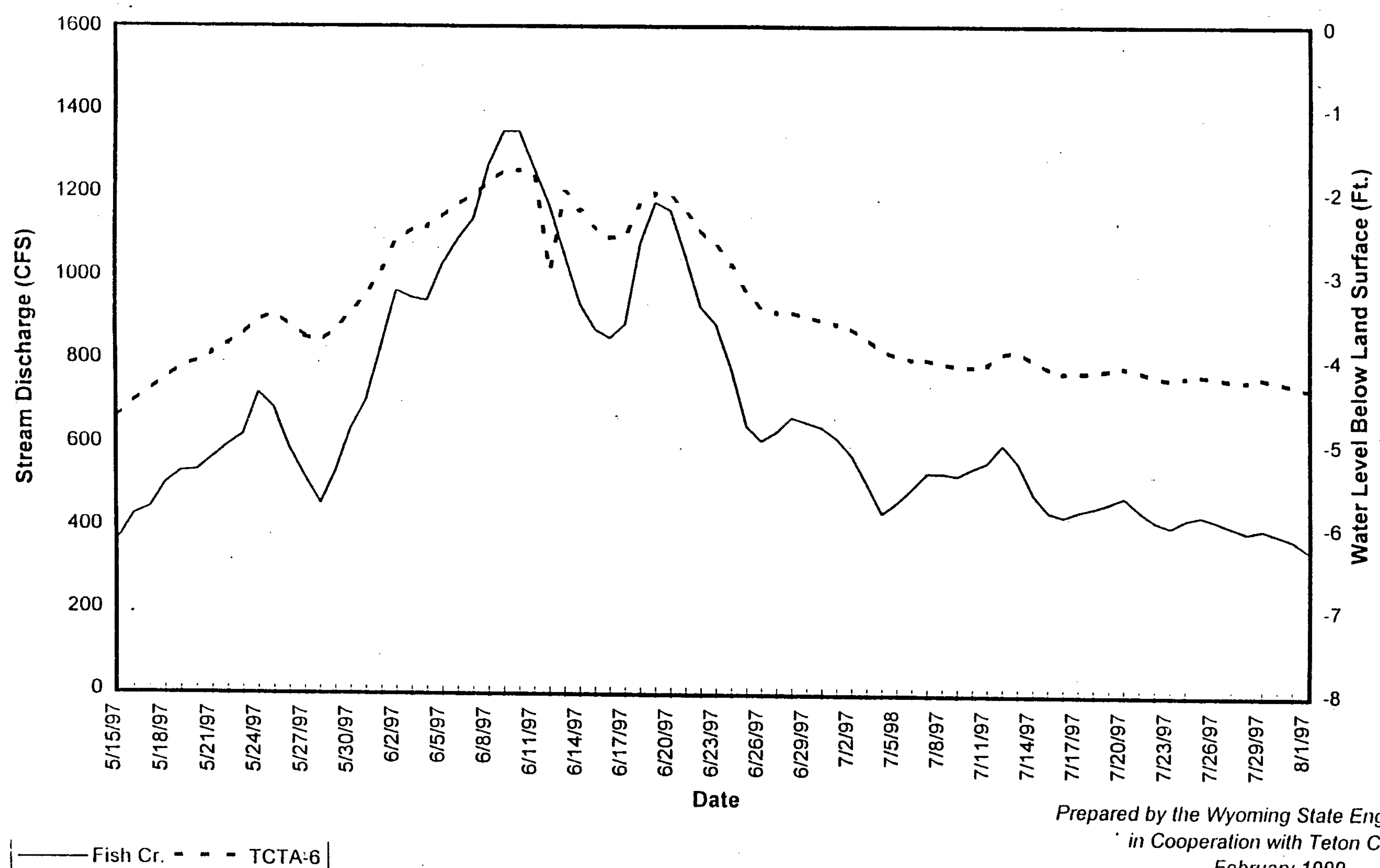
Prepared by the Wyoming State Engineer's Office
in Cooperation with Teton County
February 1999

Fish Creek Discharge -vs- Ground Water Level
Fish Creek At Wilson
Observation Well TCTA-5

Fish Cr. - - - TCTA-5

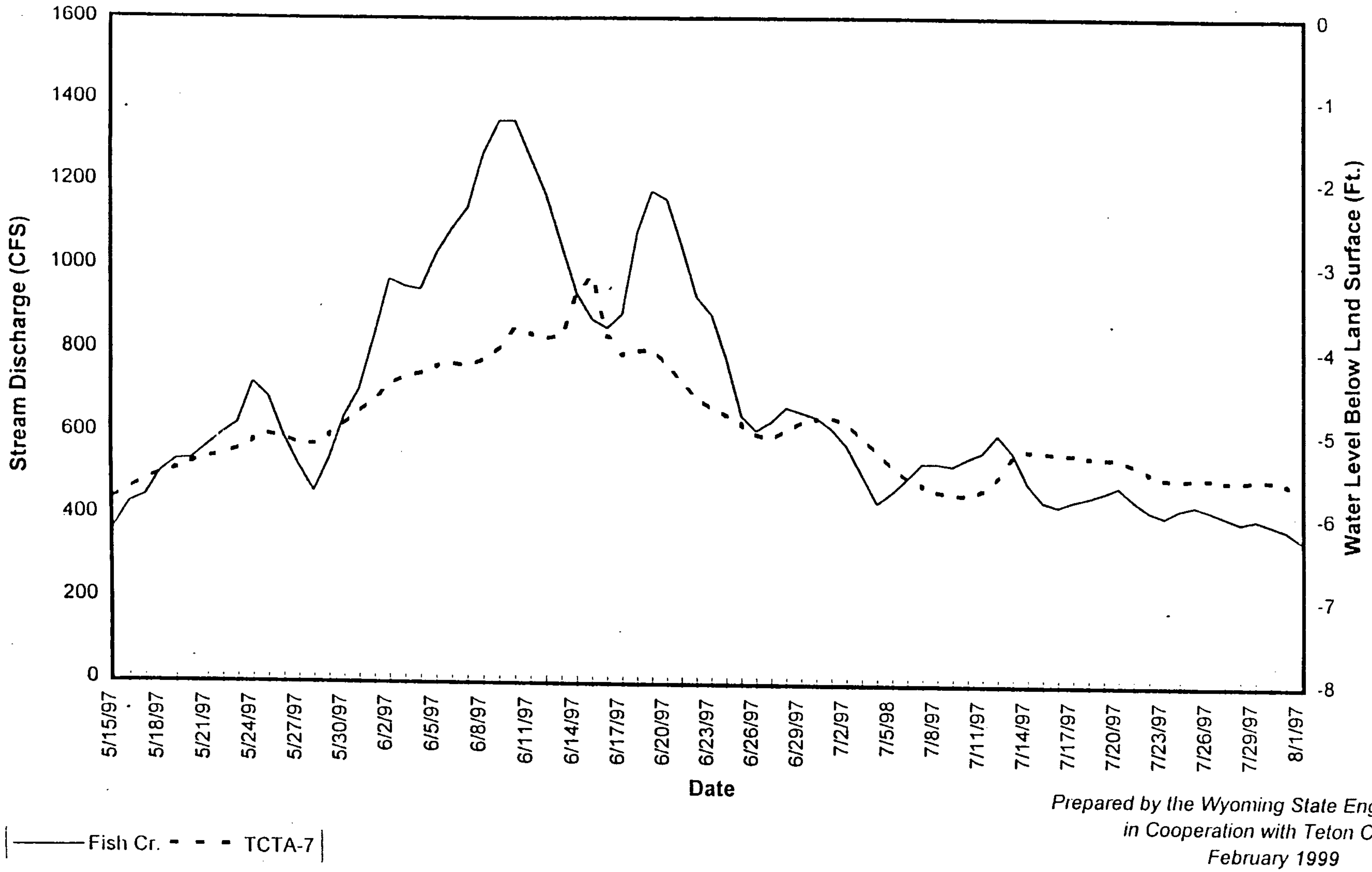
Prepared by the Wyoming State Engineer's Office
in Cooperation with Teton County
February 1999

Fish Creek Discharge -vs- Ground Water Level
Fish Creek At Wilson
Observation Well TCTA-6



Prepared by the Wyoming State Engineer's Office
in Cooperation with Teton County
February 1999

Fish Creek Discharge -vs- Ground Water Level
Fish Creek At Wilson
Observation Well TCTA-7



Prepared by the Wyoming State Engineer's Office
in Cooperation with Teton County
February 1999

PART VII. GROUND WATER OBSERVATION vs SNAKE RIVER FLOWS

b) Hydrographs Comparison

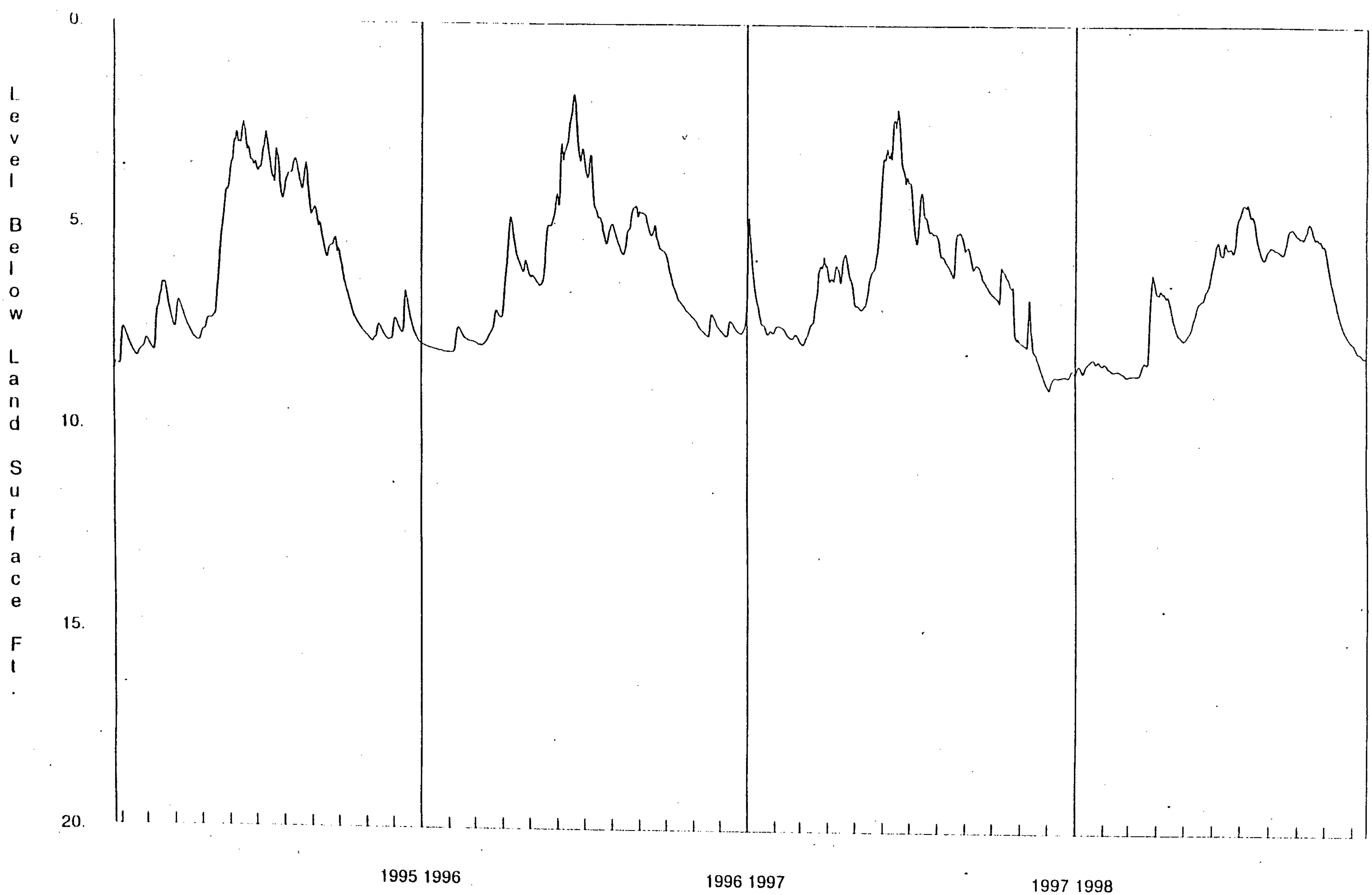
1. Surface Water Hydrographs 1997

2. Ground Water Hydrographs 1995/1998

Teton County

41 117 23cac

432954110512500



CTA-2

Legen ecorded Data

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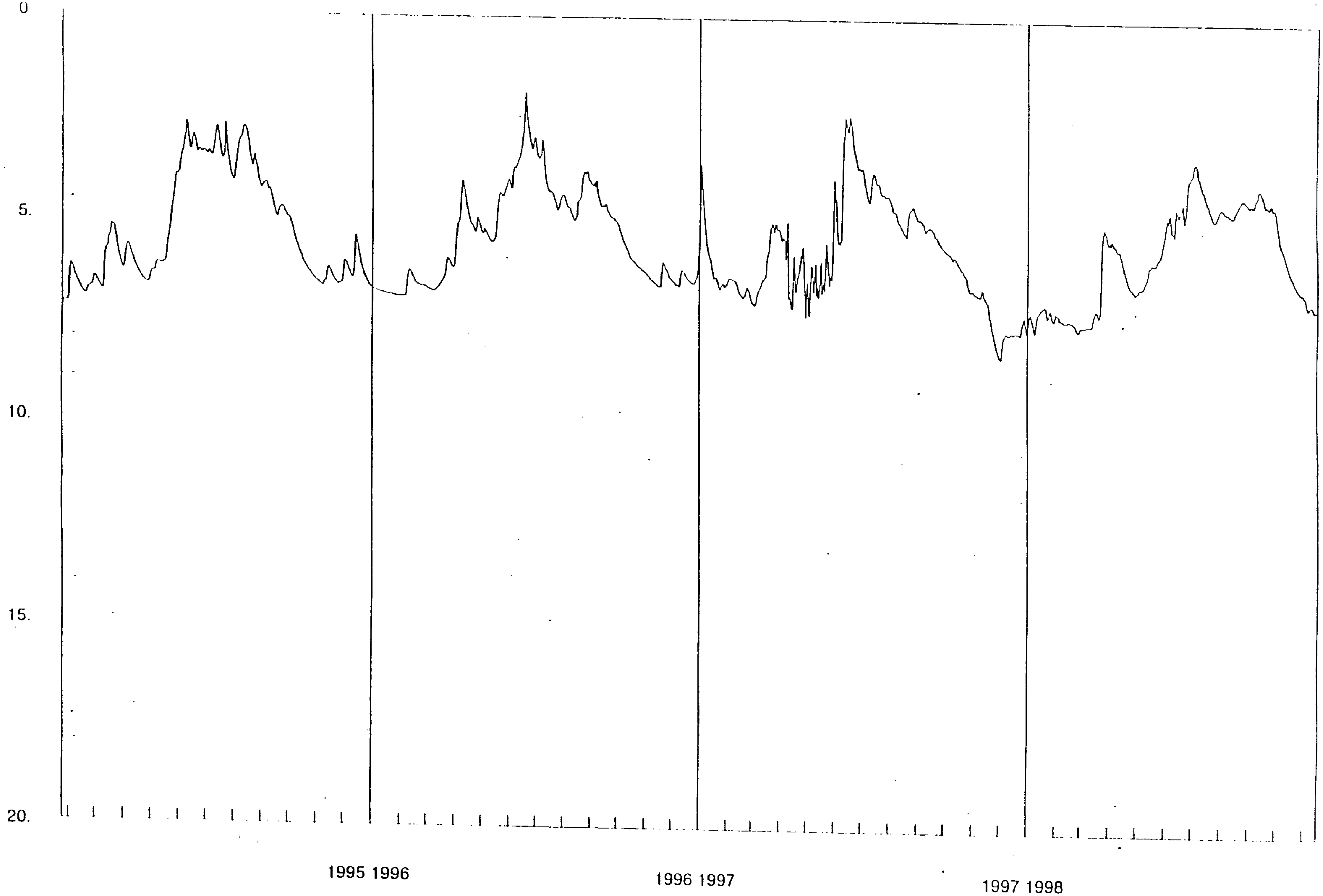

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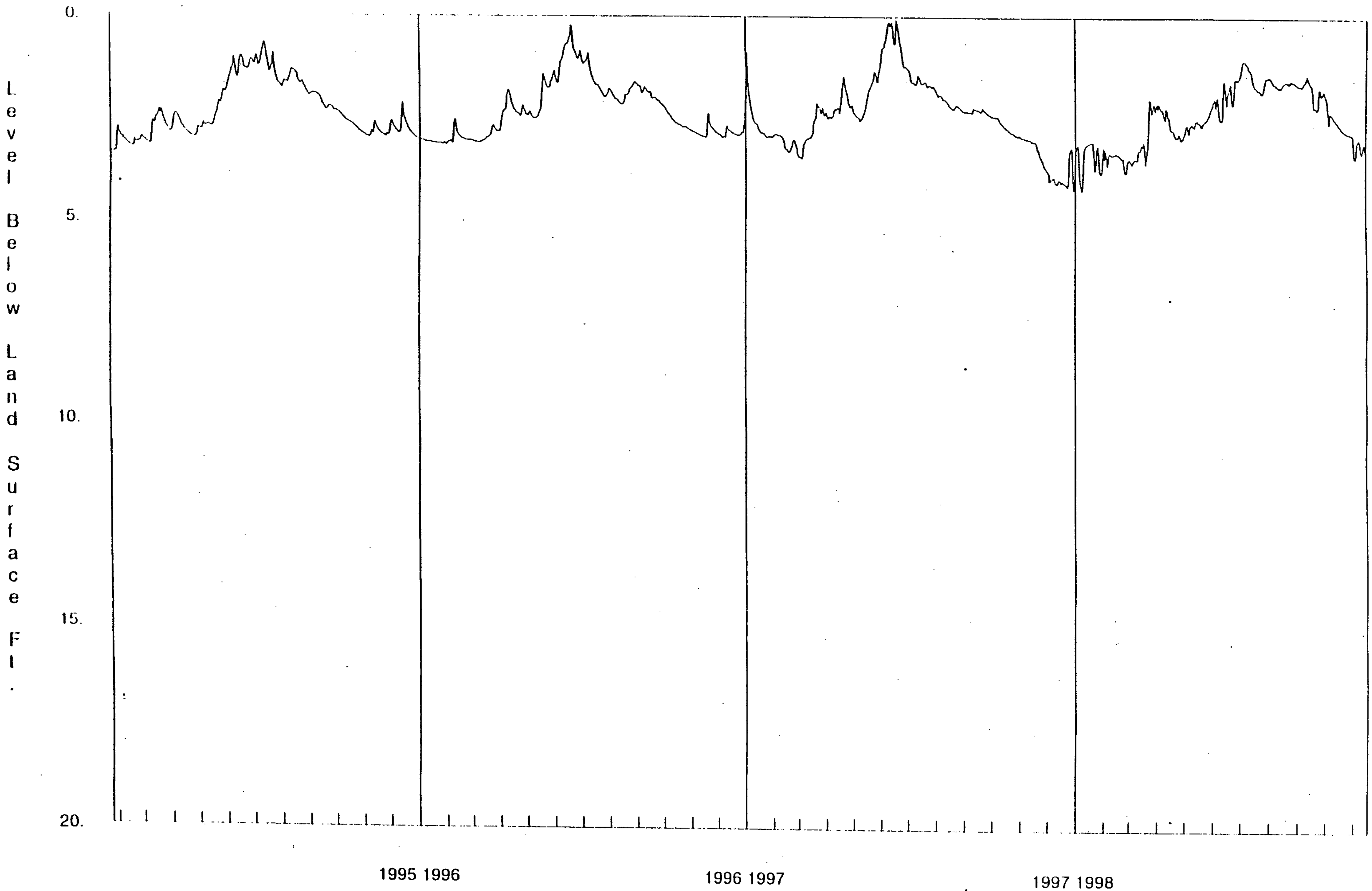

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Office in Cooperation with eton Count

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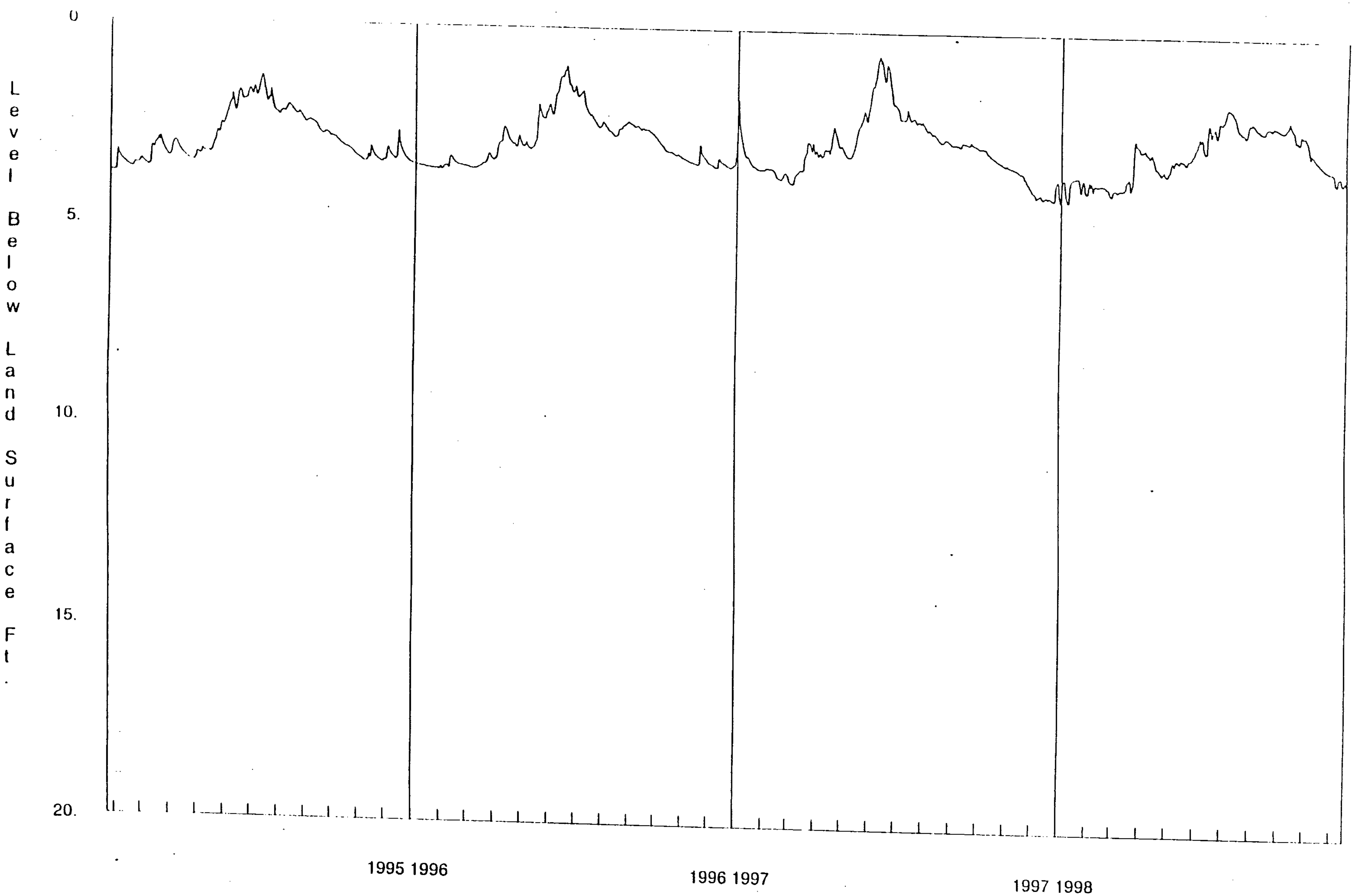

CTA-5

Prepared by the Wyoming Sta Engineer's

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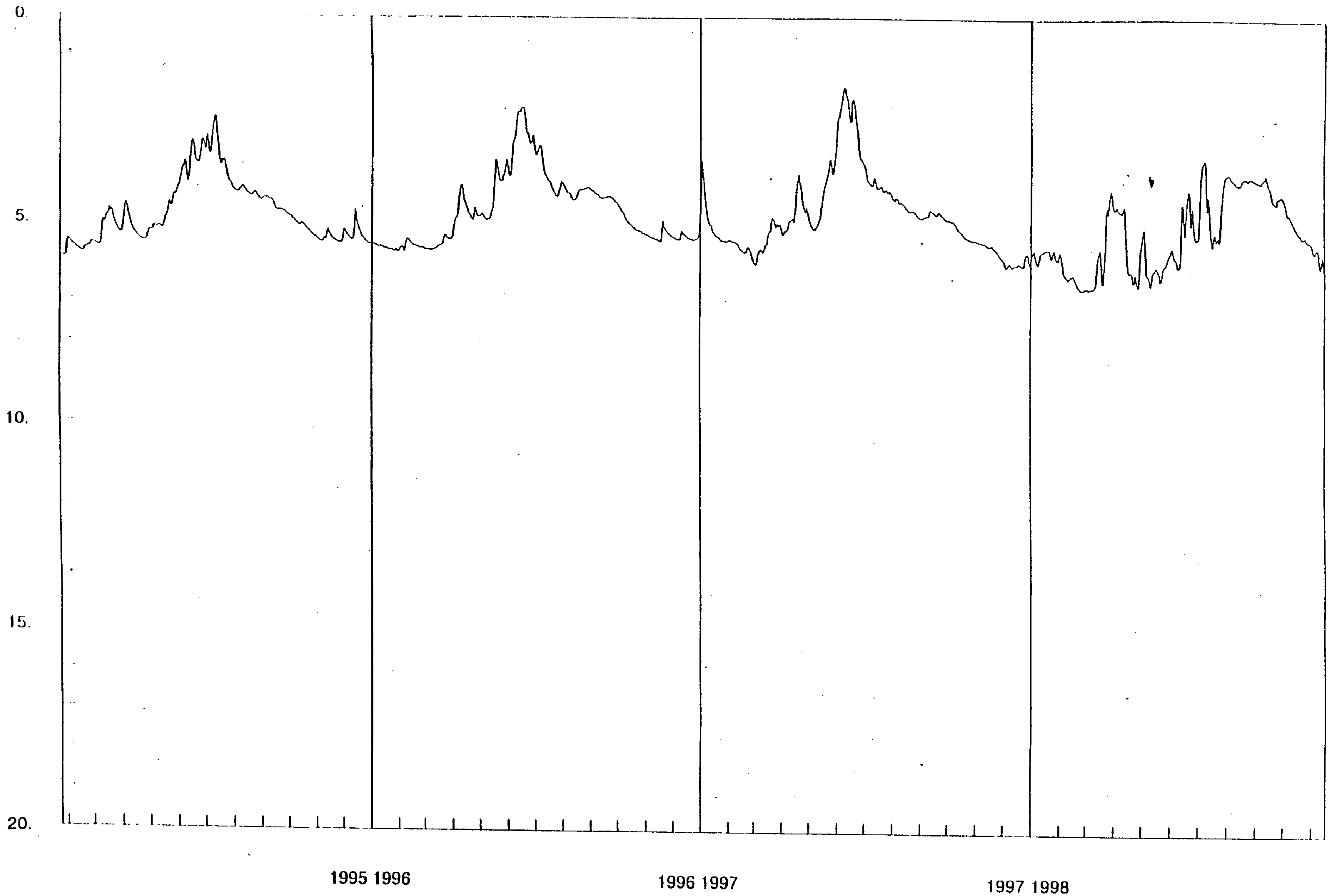
433012110521700



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Prepared by the Wyoming State Engineer's
Office in Cooperation with Teton County

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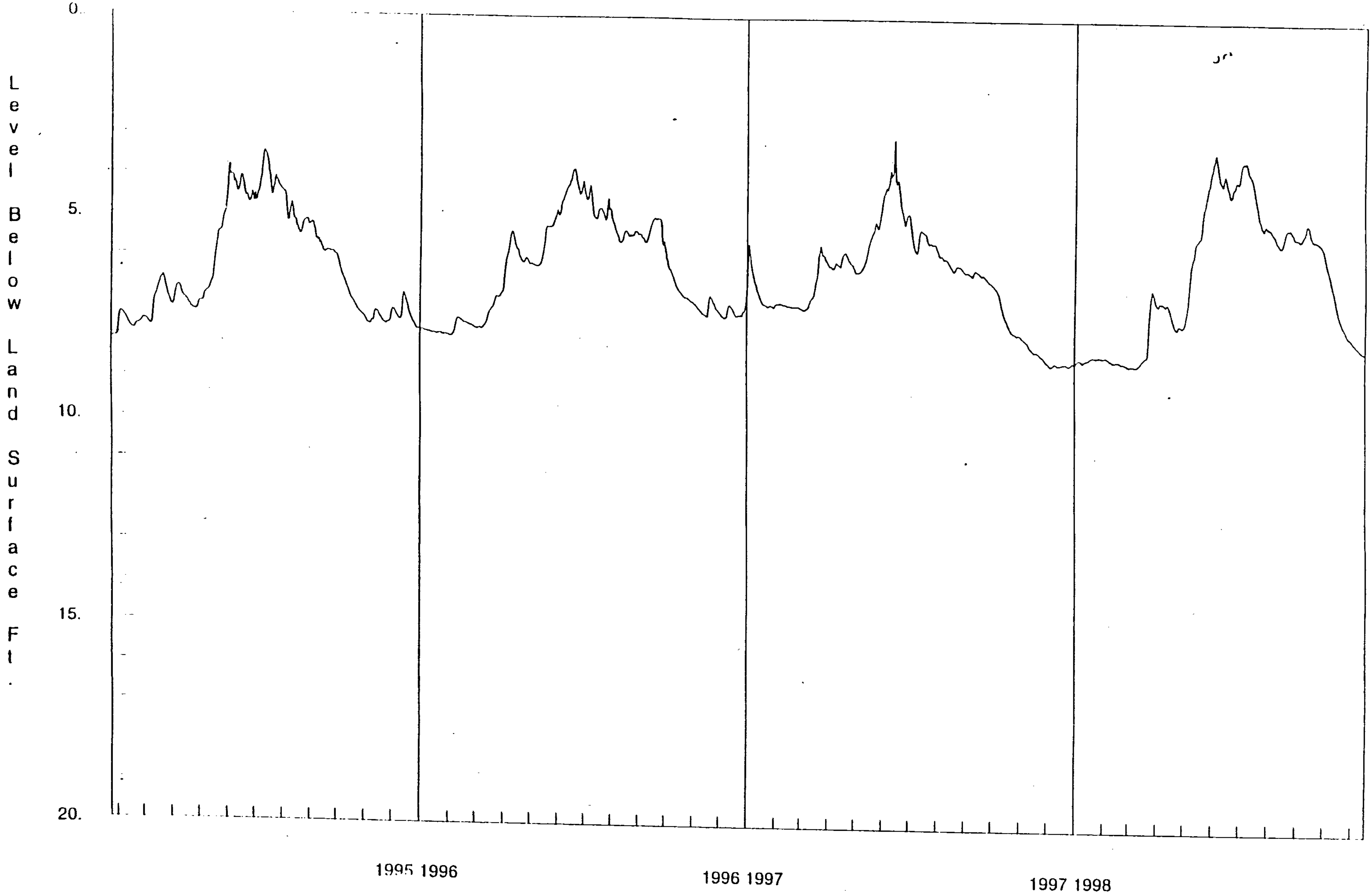

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CTA-7

Prepared by the Wyoming Sta Engineer's Office in Cooperation with .on County

PART VIII. SUMMARY

Due to the infancy of the Ground Water and Surface Water Monitoring Systems there is no conclusions to be drawn at this point in time. This appendix contains data that has been collected as a part of a data base that will be completed in the future.

As the restoration effort continues in the future, the existing monitoring systems will prove to be valuable tools to track what effects if any the restoration measures will have on the State of Wyoming water resource.

ACKNOWLEDGEMENTS

WYOMING STATE ENGINEER'S OFFICE

U.S. ARMY CORPS. OF ENGINEER'S, WALLA WALLA DISTRICT

TETON COUNTY COMMISSION

TETON COUNTY NATURAL RESOURCE DISTRICT

U.S. GEOLOGICAL SURVEY, WATER RESOURCES DIVISION

GRAND TETON NATIONAL PARK

LOCAL RESIDENTS THAT PROVIDED MONITORING SITES

APPENDIX D

ENGINEERING

OF THE

JACKSON HOLE, WYOMING, ENVIRONMENTAL RESTORATION FEASIBILITY STUDY

APPENDIX D
Engineering
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TABLES

PLATES

APPENDIX D
Engineering

1. GENERAL.

The purpose of the Jackson Hole, Wyoming, Environmental Restoration Feasibility Study is to provide environmental restoration on the Snake River near Jackson Hole, Wyoming. The Snake River, in this area, is confined by levees that concentrate the river flows causing excessive erosion of existing vegetation and wildlife habitat.

In an effort to protect the remaining vegetation and encourage growth of new vegetation, several tools for protection and environmental restoration were developed in this study. These tools would be implemented for environmental restoration in four different areas as shown on plate 1.

2. SURVEY AND MAPPING.

Topographic mapping for the project was developed from controlled aerial photography. The aerial photography was flown on 8 October 1996 at a scale of 1:6,000. The products generated from the aerial photography include contours spaced on 2-foot intervals, a digital terrain model, and a three-dimensional landscape model. No topography was generated for low-flow channels covered by water during aerial photography flights.

Prior to final design and construction, additional mapping may be warranted. This will depend on the level of topographic change from the original flight date. Additional mapping may require that field surveys of the existing channel be conducted.

3. GEOTECHNICAL.

The proposed project is located within a glacial outwash plain. This plain forms the valley floor of Jackson Hole, Wyoming, and is underlain by deep deposits of alluvial materials. There are several types of alluvial materials present, which include shales, sandstones, limestones, conglomerates, and basalts.

The subsurface was explored by excavating test pits at three different locations for each of the sites from August through November 1996 (plates 2, 3, 4, and 5). At each location, five test pits were excavated with one test pit centered amongst the other four. The other four test pits were situated radially outward 20 to 30 feet from the center test pit.

Samples were obtained with a track mounted excavator with a 1-cubic-yard bucket. Prior to sampling, the top 12 inches of material was scalped off at each test pit

to remove the cobble armor layer. Then approximately 1 cubic yard of material was removed to a depth of 3 to 4 feet from each test pit. The material obtained from the five test pits was combined and a 1-cubic-yard sample was taken from the mixture.

The samples were then shipped to a testing laboratory for performing particle size analyses. The samples were then classified in accordance with the Unified Soil Classification System. Plate 6 presents the results from the particle size analyses.

Subsurface materials encountered at each of the sites were very similar. The riverbed is generally composed of a cobble layer on the surface underlain by poorly-graded gravel with sand except one location, site 9, a well-graded gravel with sand was encountered. The cobble layer is approximately 12 inches thick with a maximum particle size of 12 inches. Based on field observations, it is estimated that 50 percent of the cobble layer has a minimum particle size of 4 inches or larger. It is expected that the gravel layer extends in depth past the zone of influence for all of the structures. Groundwater in the test pits was located at the same elevation as the adjacent river elevation, as expected for this type of material.

Each of the project sites is bordered by levees composed of gravels and cobbles. The surface of the levees facing the river is armored with 3-foot-minus riprap.

Table 3-1 is a list of the soil parameters for the gravel encountered in the test pits:

Table 3-1. SOIL PARAMETERS

Parameter	Value
Saturated unit weight	134 pounds per cubic foot
Dry unit weight	120 pounds per cubic foot
Effective unit weight	72 pounds per cubic foot
Angle of internal friction	30 degrees
Subgrade reaction	26 pounds per cubic inch

A demonstration project was constructed during the fall of 1998 that included 6-inch-diameter pipe piles driven to construct brush fences. Twenty-foot-long sections of pile were driven with a vibratory pile hammer mounted on a hydraulic excavator. All piles were driven successfully with no problems encountered. This is a good indication that penetration of the subsurface materials for construction of brush fences will not be a problem.

4. <u>RESTORATION TOOLS</u>.

The project involves five restoration tools that were adopted from other river restoration projects. Due to the extreme nature of river conditions, each restoration tool

was designed to withstand high-river forces. The restoration tools consist of gravel removal, brush fences, anchored root wad logs, rock grade control, and spur dikes.

a. Gravel Removal.

The functions for gravel removal consist of improving fish habitat, maintaining channel capacity, increasing channel stability, and improving sediment transport. Three different gravel removal tools would be used to perform these functions. They include channel capacity excavations, side pools, and sediment traps. The locations for gravel removal are shown on plates 2, 3, 4, and 5.

(1) Channel capacity Excavations.

One of the primary objectives of the project is to increase the vegetation between the levees. If this objective is achieved, then the flow capacity of the river will diminish. In order to maintain the current flow capacity, it would be necessary to remove some of the existing riverbed material. The removal of riverbed material would be accomplished with channel capacity excavations, which would be needed in areas 4, 9, and 10. No channel capacity excavations are planned for area 1. Area 1 currently has a very large flow capacity and has room to allow for the projected growth of vegetation without creating a potential flood hazard.

Channel capacity excavations would be designed to maintain the 100-year flood while considering the projected amount of vegetative growth between the levees. The amount of vegetation corresponds to the projected amount of channel blockage. Excavations would vary in depth from nothing to 8 feet with an average depth below ground of 4 feet. Excavations would extend down to the existing thalweg elevation unless indicated otherwise in appendix B.

In order to maintain channel bottom stability, the channel bottom would be armored with 4-inch-plus material obtained from the excavation. The armor material would be placed in rows spaced 10 feet apart on center aligning perpendicular to the channel centerline. The rows would have a cross-sectional area equivalent to 10-square feet. This would provide a volume of armor equivalent to a 1-foot-thick layer of armor on the channel bottom.

(2) Side Pools.

Side pools would be excavated in the existing gravel bars to provide pools for fish habitat. The gravel bars are very expansive, generally up to 600 to 800 feet in width and barren. To minimize excavation, side pools would be sited in existing low-lying areas.

Pools would be excavated to provide approximately 4 feet of water depth during low flow. In order to create a natural appearance and to maximize wildlife

benefits, the slopes of the pools would be varied (plate 7). The upstream end of the pools would be protected with a 12-inch-thick layer of cobbles.

Supply channels would be needed to provide water to and from the side pools. Existing secondary channels would be cleared through excavation, as much as possible, to allow water to run to and egress from the pools. In areas where no secondary channel exists, new channels would be excavated. To add fish value, the depth of excavation would be varied from 1 to 4 feet below the low flow water line. The estimated average depth of these excavations is 1 foot with a bottom excavation width of 4 feet.

(3) Sediment Traps.

Sediment traps would be excavated to catch bed load movement, thereby, lessening downstream sediment deposition and improving channel capacity. A secondary benefit would be improved fish habitat from the creation of a large pool.

Sediment traps would vary from 20 to 35 acres in surface area and would be excavated to the existing thalweg elevation. The depth of excavation generally varies from 2 to 6 feet with an average of 4 feet. The side slopes would be varied (plate 7). Similar to the channel capacity excavations, the bottom of the excavation would be armored with 4-inch-plus material that would be placed in wind rows.

b. Brush Fences.

Brush fences have two main purposes: reestablish island riparian habitat and protect existing island riparian habitat. Brush fences and woody debris placement would be used to slow water velocities and reduce energy impacting the islands. The intent of slowing the water velocities is to decrease island erosion and induce sedimentation and natural island-building processes. In addition, rock grade control structures would be positioned in areas to prevent channel downcutting.

The brush fence tool was developed to collect floating woody debris to form a shield that would protect existing riparian zones and induce sedimentation downstream of the brush fence. The brush fences would be situated to protect islands with existing riparian habitat. They would also be situated along barren islands to induce island building processes through sedimentation.

There are two types of brush fence designs. One brush fence design consists of piling with lateral cables strung between the piling. The other bush fence design is constructed of riprap.

(1) Piling Brush Fences.

Several load conditions were used in the design of the piling brush fence. The load conditions consisted of the following:

- Impact from a floating log on a single pile.
- Impact from a floating log on a cable.
- Static hydraulic head from river flows behind the fence.

The flow velocities used to determine the force for each load condition were 5, 8, and 12 feet per second (fps). These velocities are representative of the 15-, 25-, and 50-year flood flow velocities. Based on the analyses, the piling type, minimum pile penetration depth, and wire rope size were determined. This information is presented in table 4-1.

Table 4-1. PILING SIZES

Water Velocity (feet per second)	Piling	Minimum Penetration (feet)
5	Pipe (6" X .432")	12
8	H - Pile (8 X 36)	14
12	H - Pile (10 X 42)	16

Other options were considered such as attaching a synthetic mesh or round timbers to the piling. It was determined that these options do not have the strength to withstand the river forces for the given flow conditions and were eliminated. Timber piling was also considered for piling and was found to be able to withstand the load conditions with velocities up to 5 fps. However, due to the high bed load movement in the river, timber piling was eliminated from further consideration because the timber would rapidly breakdown.

(2) Rock Brush Fences.

The purpose for considering a rock brush fence is to investigate an alternative to a piling fence that would be suitable for withstanding the high river forces. The rock brush fences would consist of riprap with side slopes of 2 horizontal to 1 vertical and an embedment depth of at least 4 feet below the adjacent ground line. Riprap would be placed to a top elevation of 1 foot below the 100-year flood. Riprap would be sized to meet gradation 4 (table 6-2).

c. Anchored Root Wad Logs.

Root wad logs would be anchored to the river bottom (plate 8). These two methods would be employed in their placement: staggered placement and scattered placement. Staggered placement would be used to protect existing islands and to

encourage the growth of new islands. Whereas, scattered placement would be used to increase the amount of woody debris in the river system.

Toggle bolt anchors would be used for securing the logs to the river bottom for both types of placement. One such anchor is the Manta Ray Anchors, which is capable of developing the required pullout resistance. Since scour possible under the anchored woody debris, anchors would be embedded an additional 4 feet past their required embedment depth.

Anchor systems were designed for flow velocities at 5, 8, and 12 fps. Based on the analyses, it was determined that for all flow conditions two anchors would be adequate. It was also determined that for water velocities of 5 and 8 fps a 1/4-inch wire rope would be adequate and for water velocities of 12 fps a 5/16-inch wire rope would be adequate.

Another type of anchor that could be used for securing the root wad logs are helical anchors. These anchors have three flights of auger welded to the bottom of a steel rod. The steel rod is turned to advance the anchor into the ground. If scour occurs under the woody debris, these anchors would leave a steal rod sticking out of the ground. Since this may be a safety hazard, these types of anchors would not be used.

d. Rock Grade Control.

A rock grade control structure would be used in area 9 to keep the river from eroding through existing riparian habitat. The rock grade control structure would consist of riprap meeting the requirements for gradation 4 (table 6-2). The top surface of the rock grade control structure would be flush with the existing channel bottom.

e. Spur Dikes.

Spur dikes would be situated along the levees for fisheries habitat enhancement and bank protection creating flow diversity and enhance pools, riffles, and seams. (Seams are edges where high and low energy currents meet.)

There are two kinds of spur dikes under consideration: kickers and bank barbs. Kickers, which are the larger of the two, would be composed of riprap armor with a random fill core and extend approximately 56 feet into the river. Bank barbs would consist of only riprap and extend approximately 26 feet into the river. The larger size of the kicker would provide a scour hole at the end of the kicker and more slack water for fish habitat. Whereas, a barb would provide less slack water and no scour hole for habitat but would be less costly. Piling spur dikes were also considered as an option but have been dropped from this feasibility study. This option was eliminated from further consideration because piling would have to be driven through existing riprap on the levees and driven in flowing water making this option unfeasible.

5. CONSTRUCTION.

Due to the varying nature of site conditions, a Corps hydrologist and a Corps biologist would be on site to ensure that the project was constructed as planned. It is anticipated that the work would be contracted out through an equipment rental contract.

a. Gravel Removal.

Work would be accomplished with excavators, loaders, dump trucks, and grizzliest Construction equipment would not be operated in flowing water. In order to keep the equipment out of flowing water, it would be necessary to divert the water away from the excavations. This would be accomplished with diversion dikes and/or diversion channels. Diversion dikes would be constructed with existing riverbed material adjacent to the dike.

Excavations would be performed to the elevations as indicated in appendix B. Grade tolerances would be plus or minus 6 inches. The typical excavation would range in depth from 2 to 6 feet below the adjacent ground line. Excavation material would be processed through a grizzly to screen out the 4-inch-plus material until enough 4-inch-plus material was obtained for armoring the channel bottom. The 4-inch-plus material would be separately stockpiled on site for later use. The 4-inch-minus material would be hauled off site. After excavating to grade, the excavation (new channel) would be armored with the 4-inch-plus material.

b. Piling Brush Fences.

Piling brush fences would be constructed by first excavating out the high points along the fence alignments so that the bottom wire can be installed. Next, the piling would be driven to the required penetration depths with a backhoe mounted with a vibratory hammer. Holes would then be drilled through the piling to thread the wire rope through. At every fifth piling, a wire rope connection would be welded to the piling (plate 9). After installation of the wire rope, trenches would be backfilled and compacted.

c. Rock Brush Fences.

A trench along the alignment would be excavated to a depth of 4 feet below the adjacent ground line with an excavator. The trench would be wide enough to allow for the footprint of the structure. Material from the excavation would be hauled off site.

d. Anchored Root Wad Logs.

Root wad logs existing on site would be used as much as possible to minimize the expense of hauling logs to the site. Logs hauled on site would be hauled by truck

to the locations as shown on plates 2, 3, 4, and 5. Specific locations would be designated in the field by a Corps representative.

A backhoe would be used to level out an area to place the logs so that the log would have uniform bearing along its trunk and its root would be partially embedded. The log would be fastened down with toggle bolt anchors. The anchors would be driven into the ground with a jackhammer and a jack would be used to pull up on the anchors locking them into place. The cable would be tied around the log and synched down to tighten the log to the ground.

e. Rock Grade Control.

The footprint of the rock grade control structure would be excavated (plate 10). The excavation would be performed in such a manner that flowing water would be diverted away from the work area. Material resulting from the excavation would be hauled off site. Riprap would be placed in the excavation area by carefully keying the riprap together to minimize voids to form a locked mass.

f. Spur Dikes.

The spur dikes, which include both kickers and barbs (section 4.e.), will be constructed with an excavator on the levee (plate 10). Dump trucks would haul materials to the spur dike location along the top of the levees.

6. CONSTRUCTION MATERIALS.

a. Ripap and Random Fill.

The contractor would be responsible for selecting riprap sources that would provide the necessary quantity and quality of materials meeting the requirements. The contractor would be responsible for making arrangements with individual property owners concerning availability of riprap sources and payment of royalties. One potential source would be the quarry reject pile at Walton Quarry owned by the state of Wyoming. For more information regarding this site, contact Teton County. The contractor would comply with all applicable local, state, and Federal laws and regulations including, but not limited to, the Clean Water Act; Resource Conservation and Recovery Act; and Comprehensive Environmental Response, Compensation, and Liability Act. Random fill would be obtained from the excavations or from the spoils pile located at Walton Quarry.

(1) Quality of Riprap.

Riprap would meet the following requirements (table 6-1):

Table 6-1. RIPRAP QUALITY	
Test	Requirements
Specific Gravity	Not less than 2.5%
Absorption	Not more than 2.5%
Ethylene Glycol	Not more than 10% by weight
Los Angeles Wear	30% maximum

(2) Riprap Gradations.

Riprap would have the minimum dimensions as specified in table 6-2. Neither the breadth nor the thickness of any piece of riprap would be less than one-third of its length. Rounded alluvial material and/or subrounded rock will not be acceptable. Rounded alluvial and subrounded rock will be as defined in the American Society for Testing and Materials (ASTM), D 2488.

Table 6-2. GRADATION REQUIREMENTS		
Gradation	Minimum Diameter 30% finer (feet)	Minimum Diameter 90% finer (feet)
1	1.46	2.11
2	1.70	2.47
3	1.95	2.82
4	2.19	3.17

b. Woody Debris.

Woody debris would be obtained from on-site and off-site sources selected by the contractor. It is estimated that 3,000 root wad logs, acceptable for construction, are scattered along the river. An additional 200 root wad logs are piled at Walton Quarry. The woody debris available on site would be used first. Additional woody debris would be obtained off site. Possible sources for off-site woody debris include Jackson Lake or Palisades Reservoir.

Root wad logs of deciduous and coniferous tree species would be acceptable. They would be at least 8 feet in length and no longer than 20 feet. The stem would be at least 12 inches in diameter and the roots would remain intact.

7. CONSTRUCTION ACCESS.

Access to the work areas will generally originate from the public highway system and traverse over existing easements to the levees. The roads for the levee access easements are typically dirt roads and are suitable for moving construction equipment. For cost estimating purposes, it is assumed that gravel resulting from the excavations would be hauled 12 miles from each area.

Flows in the Snake River are too high to allow for construction access from only one side of the river so access from both sides of the river would be necessary. For convenience, the following describes the access points by the west access and the east access.

a. Area 1.

(1) West Access.

The west portion of area 1 would be accessed from Fall Creek Road and involves two different access points. The first access point is for the downstream work area. The access originates off of Fall Creek Road and follows a dirt road to Sewell Levee. It would then continue along Sewell Levee to the work area. The access to the upstream work area would also originate from Fall Creek Road and would follow a dirt road to the work area. This access will need to be determined in the field.

(2) East Access.

The east portion of area 1 would be accessed from the north from South Park Loop along a 1-mile stretch of gravel road to the Lower Imenson Levee. Once on the levee, construction equipment would follow the levee until it terminates. After the levee ends, access would continue through existing shrubs and trees and over gravel bars. The contractor would coordinate with the Corps in the field to determine the optimum routes for minimizing disturbances.

b. Area 4.

(1) West Access.

Access to area 4 would be from Fall Creek Road along an existing gravel road. This access crosses an existing bridge and terminates onto the channel bottom. The contractor would then navigate across gravel bars and around existing vegetation.

(2) East Access.

The east portion of area 4 would be accessed from the Federal Levee Extension. Construction equipment would leave the public highway, approximately 4 miles to the north, and follow the left bank to the Federal Levee Extension to the work area.

c. Area 9.

(1) West Access.

Of the four areas, area 9 is the most accessible. Access for the west portion of area 9 would come from State Highway 390. From which, the contractors would follow an existing dirt road to the Right Bank Federal Levee.

(2) East Access.

Access to the east portion of area 9 would be from State Highway 22, which provides access to the Left Bank Federal Levee. From the Left Bank Federal Levee, the contractor could select an access point to the specific work areas.

d. Area 10.

(1) West Access.

Most of the work in area 10 lies to the west of the river and would be accessed via the Right Bank Federal Levee. From the levee, construction equipment would traverse across existing gravel bars and through brush to the specific work areas. Equipment could reach the levee from both the upstream and downstream directions. The downstream end of the levee would be accessed from a dirt road that runs for about three-fourths of a mile from State Highway 390 to the Right Bank Federal Levee.

(2) East Access.

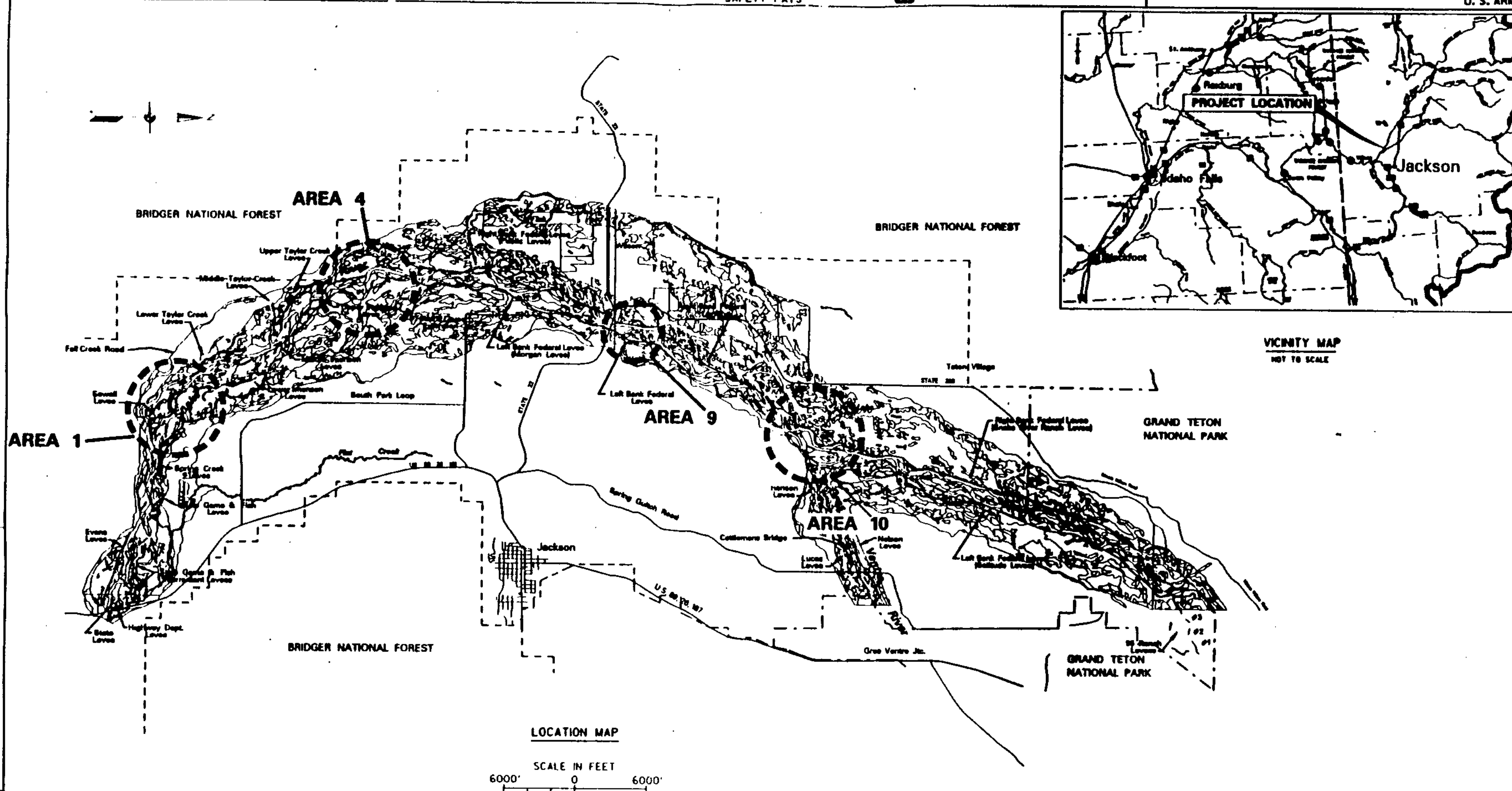
The work on the east portion of area 10 would be reached from the downstream direction or the upstream direction. From the downstream direction, equipment would travel from State Highway 22 and up the Left Bank Federal Levee for approximately 3 miles to the work areas. From the upstream direction, equipment would travel from Cattlemans Bridge, which is approximately 2 miles away, to Hanson Levee. The spur dikes located to the north would be accessed from Spring Gulch Road, which is about 2 miles away.

APPENDIX D

ENGINEERING

PLATES

CORPS OF ENGINEERS — SAFETY PAYS — U. S. ARMY



INDEX TO DRAWINGS

PLATE NO.	TITLE
PLATE 1	LOCATION, VICINITY MAPS AND INDEX TO DRAWINGS
PLATE 2	AREA 1 - PLAN
PLATE 3	AREA 4 - PLAN
PLATE 4	AREA 9 - PLAN
PLATE 5	AREA 10 - PLAN
PLATE 6	PARTICLE SIZE ANALYSES
PLATE 7	FLOW IMPROVEMENTS - PLAN AND SECTIONS
PLATE 8	ANCHORED ROOT WAD LOGS - DETAILS
PLATE 9	BRUSH FENCES - DETAILS
PLATE 10	SPUR DIKE - DETAILS

Computer Aided Design & Drafting

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

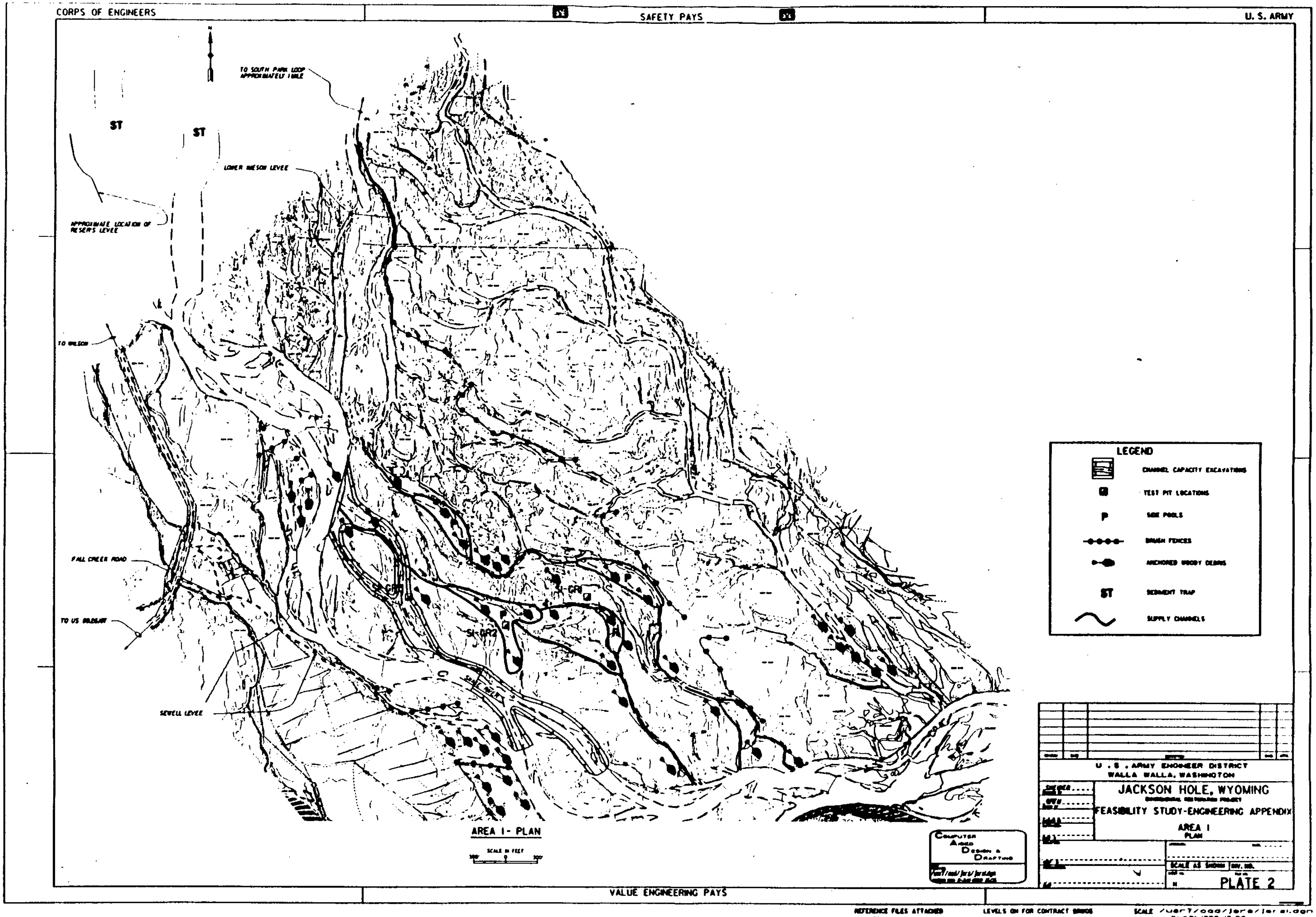
JACKSON HOLE, WYOMING
FEASIBILITY STUDY-ENGINEERING APPENDIX
LOCATION, VICINITY MAPS AND INDEX TO DRAWINGS

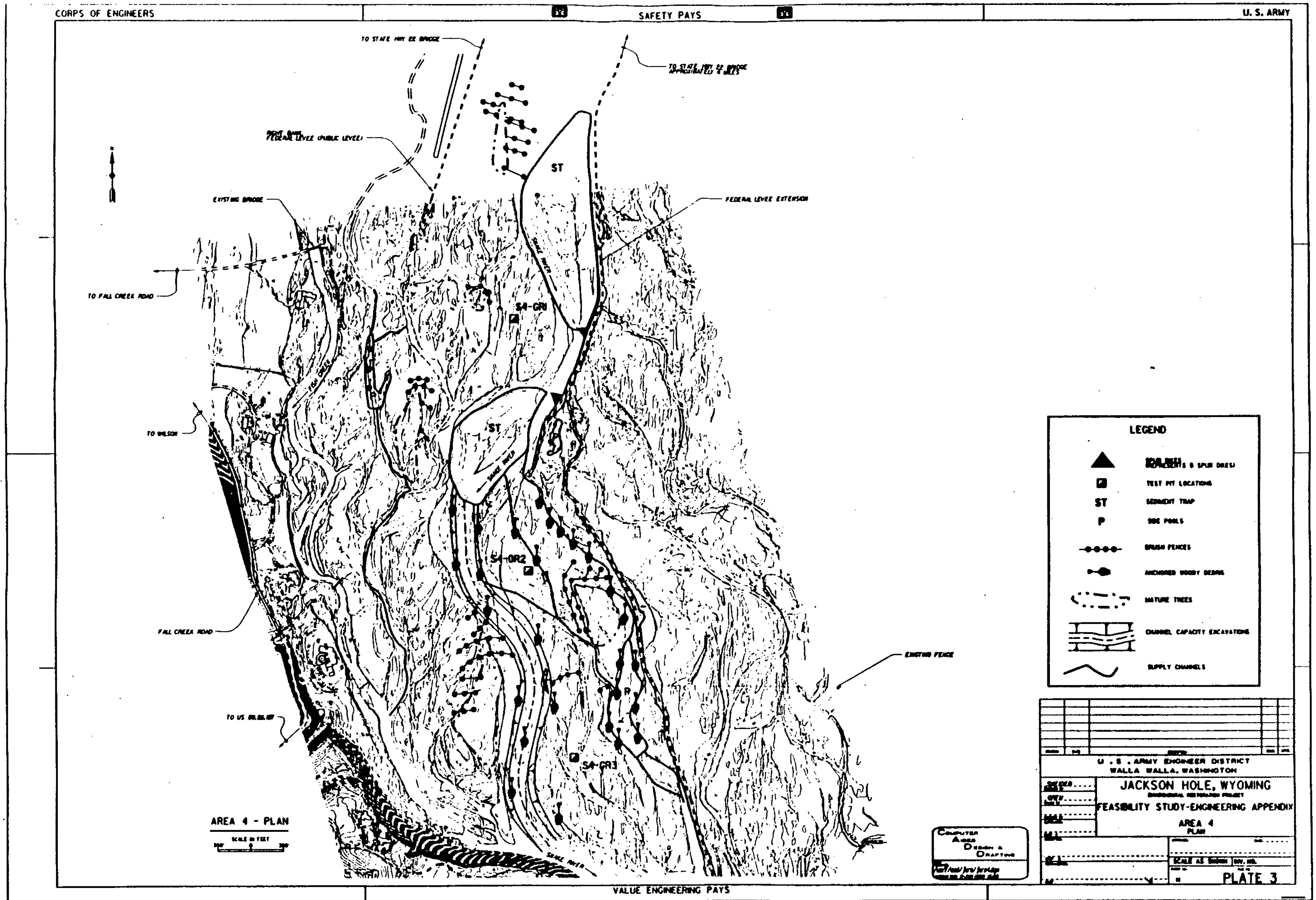
SCALE AS SHOWN

PLATE 1

VALUE ENGINEERING PAYS

REFERENCE FILES ATTACHED YES NO — LEVELS ON FOR CONTRACT DRWGS — SCALE


CORPS OF ENGINEERS
SAFETY PAYS
U. S. ARMY
TO SOUTH PARK LOOP APPROXIMATELY 1 MILE
ST
ST
LOWER WILSON LEVEE
APPROXIMATE LOCATION OF RESERS LEVEE
TO WILSON
FALL CREEK ROAD
TO US 89/US187
SEVELL LEVEE
LEGEND
CHANNEL CAPACITY EXCAVATIONS
TEST PIT LOCATIONS
P
SIDE POOLS
BRUSH FENCES
ANCHORED WOODY DEBRIS
ST
SEDIMENT TRAP
SUPPLY CHANNELS
AREA 1 - PLAN
SCALE IN FEET
U.S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON
JACKSON HOLE, WYOMING
FEASIBILITY STUDY-ENGINEERING APPENDIX
AREA 1
PLAN
SCALE AS SHOWN
PLATE 2
COMPUTER AIDED DESIGN & DRAFTING
VALUE ENGINEERING PAYS
REFERENCE FILES ATTACHED
YES NO
LEVELS ON FOR CONTRACT DRAWINGS
SCALE


CORPS OF ENGINEERS
SAFETY PAYS
U. S. ARMY
TO STATE HWY 22 BRIDGE
FEDERAL LEVEE (PUBLIC LEVEE)
EXISTING BRIDGE
TO FALL CREEK ROAD
TO WILSON
FALL CREEK ROAD
TO US
FEDERAL LEVEE EXTENSION
ST
S4-GR1
S4-OR2
S4-GR3
P
EXISTING FENCE
LEGEND
TEST PIT LOCATIONS
SEDIMENT TRAP
SIDE POOLS
BRUSH FENCES
ANCHORED WOODY DEBRIS
MATURE TREES
CHANNEL CAPACITY EXCAVATIONS
SUPPLY CHANNELS
AREA 4 - PLAN
SCALE IN FEET
U. S. ARMY ENGINEER DISTRICT
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JACKSON HOLE, WYOMING
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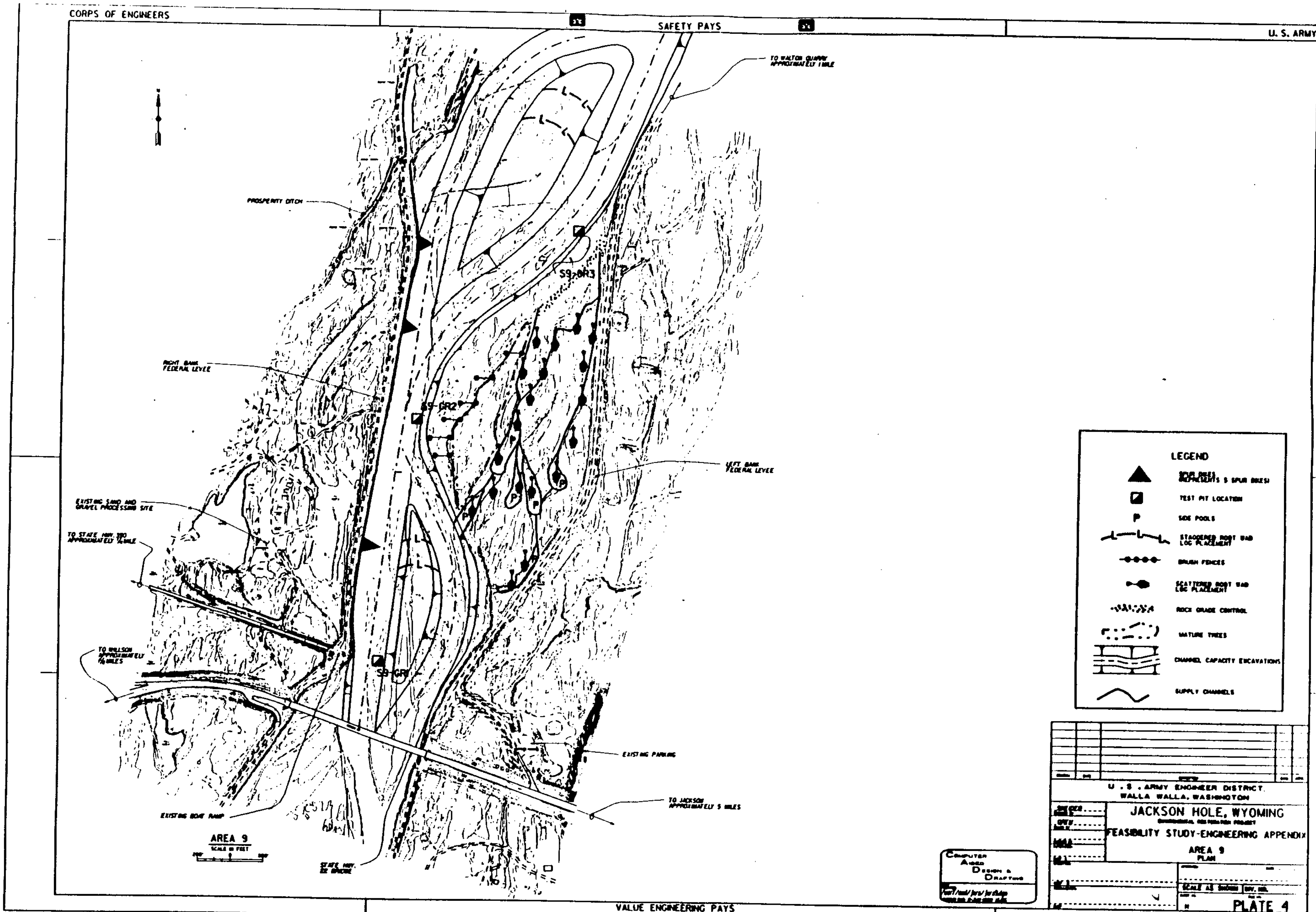
AREA 4
PLAN
PLATE 3
VALUE ENGINEERING PAYS
REFERENCE FILES ATTACHED
LEVELS ON FOR CONTRACT DRWGS



CORPS OF ENGINEERS
SAFETY PAYS
U. S. ARMY
TO WALTON QUARRY APPROXIMATELY 1 MILE
PROSPERITY DITCH
S9-BR3
S9-BR2
S9-BR1
RIGHT BANK FEDERAL LEVEE
LEFT BANK FEDERAL LEVEE
EXISTING SAND AND GRAVEL PROCESSING SITE
TO STATE HWY. 390 APPROXIMATELY ¼ MILE
TO WILSON APPROXIMATELY ¾ MILES
EXISTING PARKING
TO JACKSON APPROXIMATELY 5 MILES
EXISTING BOAT RAMP
STATE HWY. 22 BRIDGE
AREA 9
SCALE IN FEET
LEGEND
SPUR DIKES (REPRESENTS 5 SPUR DIKES)
TEST PIT LOCATION
SIDE POOLS
STAGGERED ROOT WAD LOG PLACEMENT
BRUSH FENCES
SCATTERED ROOT WAD LOG PLACEMENT
ROCK GRADE CONTROL
MATURE TREES
CHANNEL CAPACITY EXCAVATIONS
SUPPLY CHANNELS
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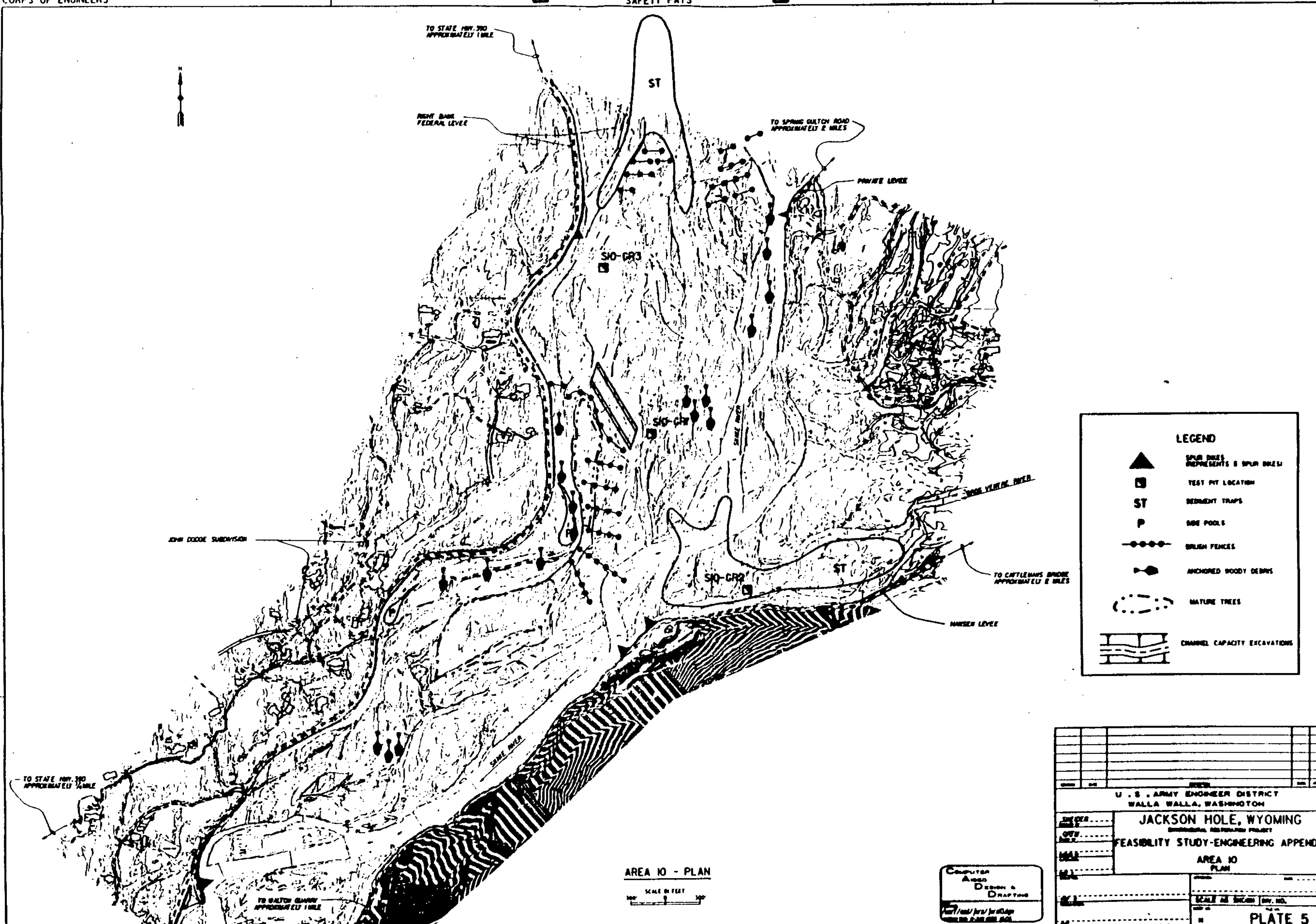
AREA 9
PLAN
SCALE AS SHOWN
PLATE 4
VALUE ENGINEERING PAYS
REFERENCE FILES ATTACHED
YES NO
LEVELS ON FOR CONTRACT DRWGS



U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

JACKSON HOLE, WYOMING

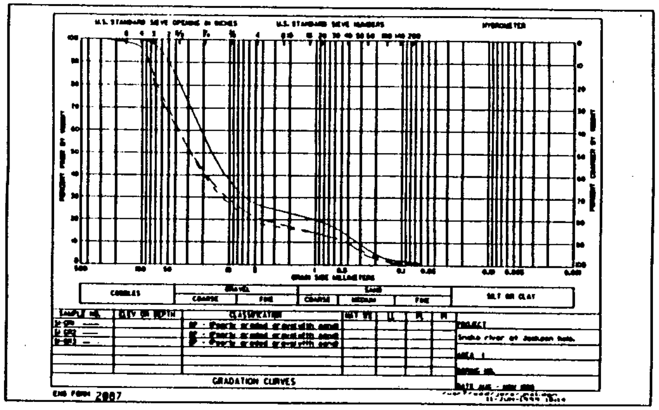
FEASIBILITY STUDY-ENGINEERING APPENDIX

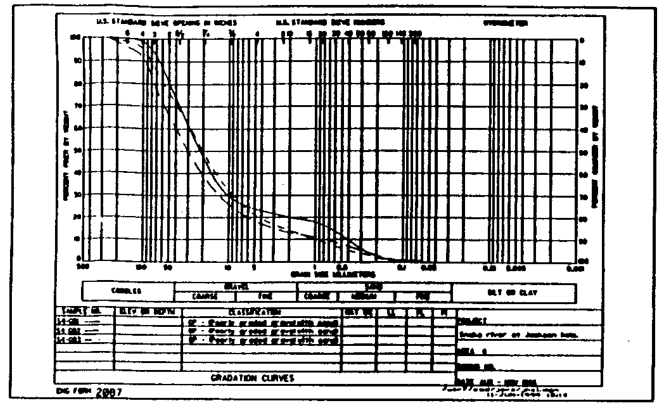
AREA 10
PLAN

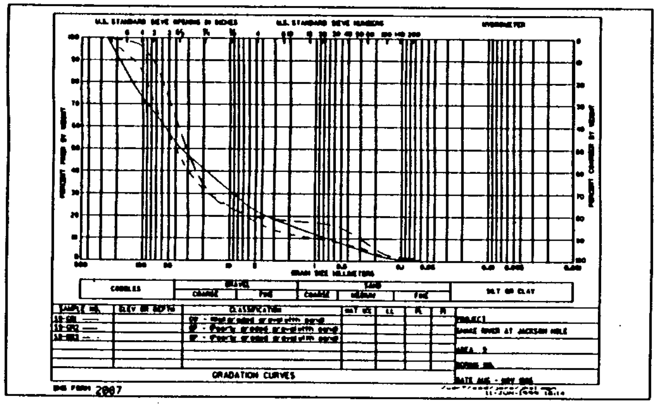
PLATE 5

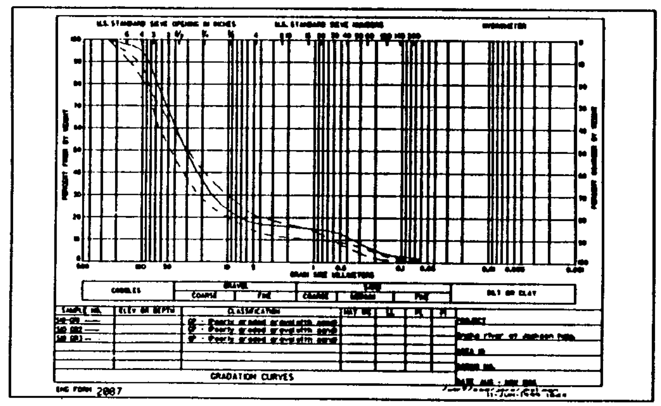
REFERENCE FILES ATTACHED YES NO LEVELS ON FOR CONTRACT DRWGS

CORPS OF ENGINEERS　SAFETY PAYS　U. S. ARMY









U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

JACKSON HOLE, WYOMING

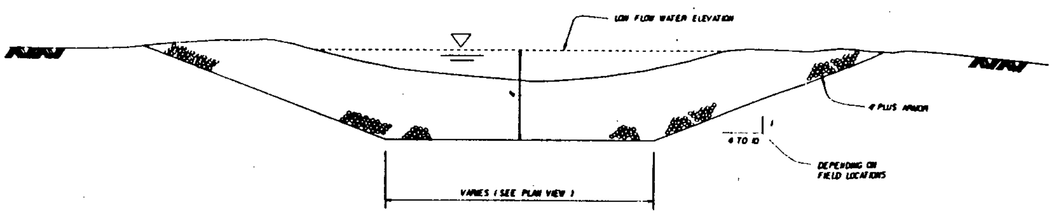
FEASIBILITY STUDY-ENGINEERING APPENDIX

PARTICLE SIZE ANALYSES

Computer Aided Design & Drafting

PLATE 6

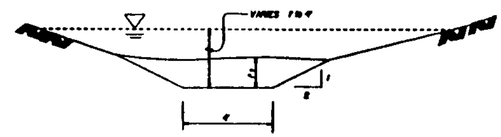
VALUE ENGINEERING PAYS



SECTION - SEDIMENT TRAP AND CHANNEL CAPACITY EXCAVATION TYP.

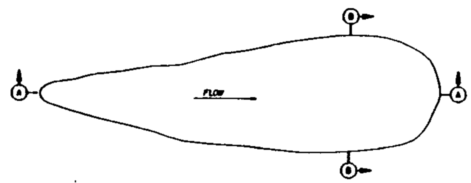
HORIZONTAL SCALE IN FEET

VERTICAL SCALE IN FEET



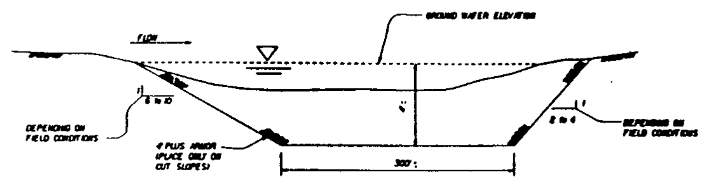
SECTION - SUPPLY CHANNEL TYP.

SCALE IN FEET



PLAN - POOL TYP.

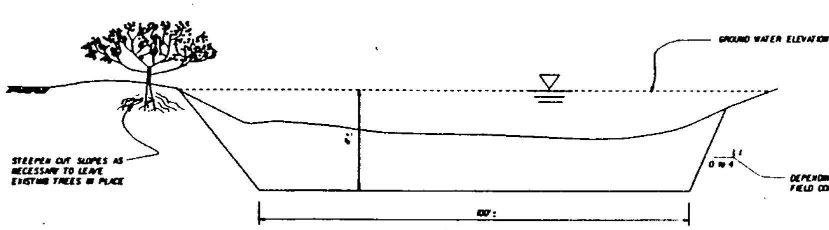
HORIZONTAL SCALE IN FEET



SECTION A - POOL TYP.

HORIZONTAL SCALE IN FEET

VERTICAL SCALE IN FEET



SECTION B - POOL TYP.

HORIZONTAL SCALE IN FEET

VERTICAL SCALE IN FEET

NOTES:

1. CUTS THAT INTERSECT EXISTING STRUCTURES SUCH AS LEVEES SHALL BE TERMINATED AT THE STRUCTURE.
2. CUT SLOPES WILL BE VARIED WITHIN THE RANGE SHOWN ON THE SECTIONS TO PROVIDE CHANNEL DIVERSITY.
3. WOODY DEBRIS WILL BE ANCHORED ON CUT SLOPES. APPROXIMATELY ONE ROOT WAD FOR EVERY 50' OF POND PERIMETER.

COMPUTER AIDED DESIGN & DRAFTING

U . S . ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

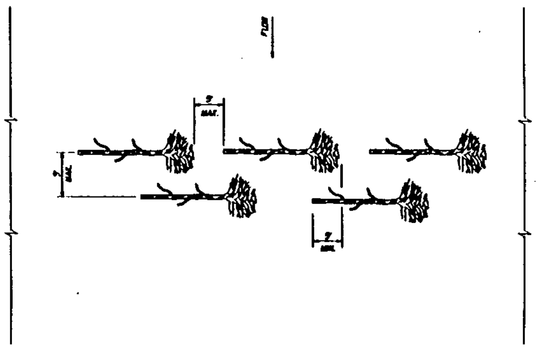
JACKSON HOLE, WYOMING

FEASIBILITY STUDY-ENGINEERING APPENDIX

FLOW IMPROVEMENTS
PLAN AND SECTIONS

SCALE AS SHOWN

PLATE 7

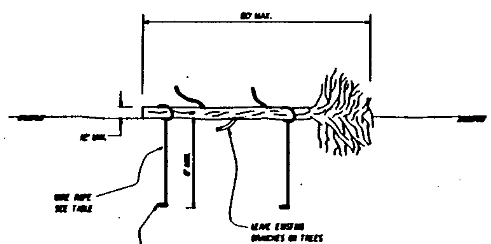


PLAN - STAGGERED ROOT WAD LOG PLACEMENT

NOT TO SCALE

NOTES:

LOGS WOULD BE RANDOMLY STAGGERED TO ALLOW FOR SHORTER LENGTH ROOT WAD LOGS. SPACING AND OVERLAPPING REQUIREMENTS MUST BE FOLLOWED AS SHOWN.



SECTION - ROOT WAD LOG

SCALE IN FEET

WATER VELOCITY (FEET PER SECOND)	REQUIRED ANCHOR PULLOUT RESISTANCE (POUNDS)	CABLE SIZE (INCHES)
5	2500	1/4
8	6000	1/4
12	8500	5/16

COMPUTER AIDED DESIGN & DRAFTING

U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

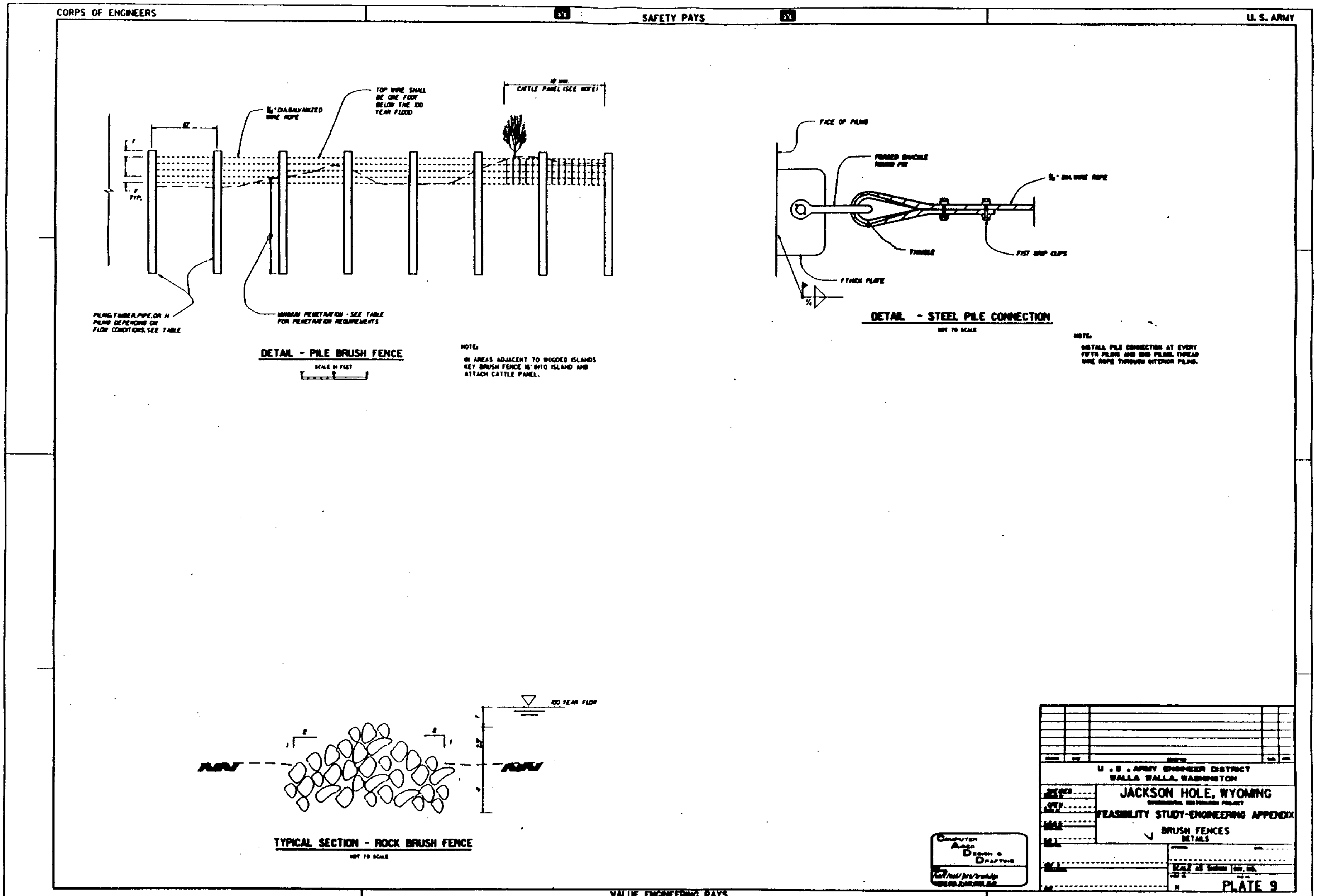
JACKSON HOLE, WYOMING

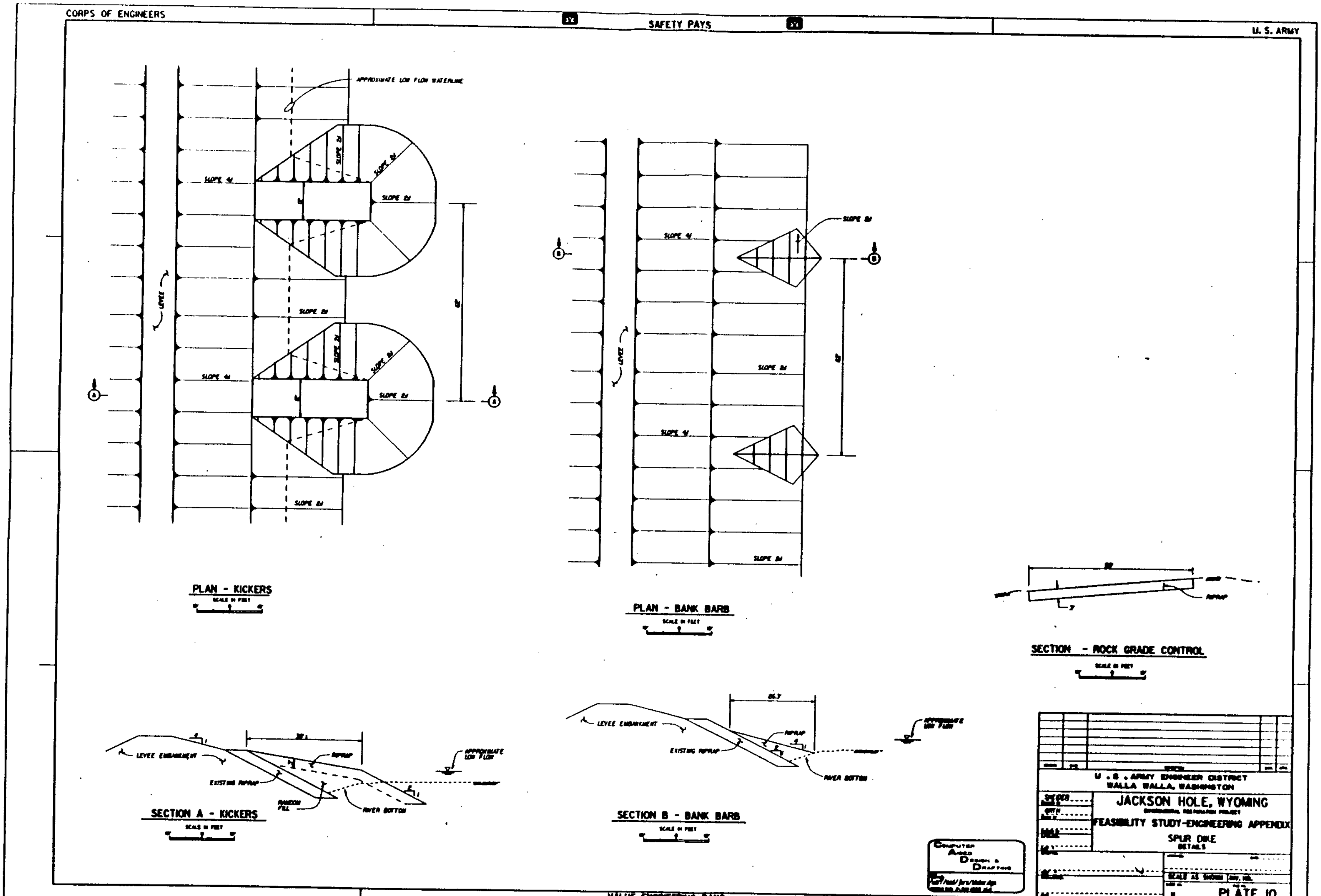
FEASIBILITY STUDY-ENGINEERING APPENDIX

ANCHORED ROOT WAD LOGS
DETAILS

SCALE AS SHOWN

PLATE 8


CORPS OF ENGINEERS
SAFETY PAYS
U. S. ARMY
CATTLE PANEL (SEE NOTE)
TOP WIRE SHALL BE ONE FOOT BELOW THE 100 YEAR FLOOD
DIA GALVANIZED WIRE ROPE
PILING: TIMBER, PIPE, OR H PILING DEPENDING ON FLOW CONDITIONS, SEE TABLE
MINIMUM PENETRATION - SEE TABLE FOR PENETRATION REQUIREMENTS
DETAIL - PILE BRUSH FENCE
NOTE:
IN AREAS ADJACENT TO WOODED ISLANDS KEY BRUSH FENCE 15' INTO ISLAND AND ATTACH CATTLE PANEL.
FACE OF PILING
FORGED SHACKLE ROUND PIN
DIA WIRE ROPE
THIMBLE
FIST GRIP CLIPS
THICK PLATE
DETAIL - STEEL PILE CONNECTION
NOT TO SCALE
NOTE:
INSTALL PILE CONNECTION AT EVERY FIFTH PILING AND END PILING. THREAD WIRE ROPE THROUGH INTERIOR PILING.
100 YEAR FLOW
TYPICAL SECTION - ROCK BRUSH FENCE
NOT TO SCALE
U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON
JACKSON HOLE, WYOMING
FEASIBILITY STUDY-ENGINEERING APPENDIX
BRUSH FENCES
DETAILS
PLATE 9
VALUE ENGINEERING PAYS


CORPS OF ENGINEERS
SAFETY PAYS
U. S. ARMY
APPROXIMATE LOW FLOW WATERLINE
SLOPE 4:1
SLOPE 2:1
LEVEE
PLAN - KICKERS
SCALE IN FEET
PLAN - BANK BARB
SECTION - ROCK GRADE CONTROL
RIPRAP
LEVEE EMBANKMENT
EXISTING RIPRAP
RANDOM FILL
RIVER BOTTOM
APPROXIMATE LOW FLOW
SECTION A - KICKERS
SECTION B - BANK BARB
U.S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON
JACKSON HOLE, WYOMING
FEASIBILITY STUDY-ENGINEERING APPENDIX
SPUR DIKE
DETAILS
PLATE 10
COMPUTER AIDED DESIGN & DRAFTING
VALUE ENGINEERING PAYS
REFERENCE FILES ATTACHED
YES NO
LEVELS ON FOR CONTRACT DRAWS

APPENDIX E

ECONOMIC

OF THE

JACKSON HOLE, WYOMING, ENVIRONMENTAL RESTORATION FEASIBILITY STUDY

Prepared by

Tetra Tech, Inc.

Appendix E Economic

Table of Contents

List of Tables

Introduction

The Jackson Hole feasibility study is being conducted to evaluate environmental restoration alternatives along the Snake River near Jackson, Wyoming. Problems identified in the study included declining habitat diversity and sustainability, declining quantity and quality of in-stream aquatic habitat, declining quantity and quality of wetland and riparian habitat, and declining habitats for sensitive, threatened and endangered species. Much of the decline has been attributed to the federal levee system throughout most of the study area. Originally 12 sites were identified for potential restoration. A significance-based preliminary screening framework was developed (see Section 4.3.1 of the Main Report) that reduced the twelve sites to four for detailed environmental and economic evaluation. Four alternatives were examined at each of the four sites resulting in sixteen alternative restoration plans

Overview of Analysis

In order to evaluate the cost efficiency and environmental effectiveness of the sixteen alternatives being considered in the Jackson Hole Environmental Restoration Study, cost effectiveness and incremental cost evaluations were conducted. Cost effectiveness evaluations were conducted to identify those alternatives that were clearly more cost effective than others (they provide more output for the same or less cost, or the same output for less cost). Incremental cost analysis of the cost effective alternatives was then conducted to identify those alternatives that were the most efficient at producing increasing levels of environmental outputs (they provide additional levels of output at the lowest additional cost per unit). The results of these analyses are presented in this Economic Appendix to help inform the selection of a cost effective recommended restoration plan for the Jackson Hole study.

Alternatives

Sixteen alternatives were evaluated in the Jackson Hole study. These alternatives were made up of four different configurations of management measures at each of four project areas.

Project Areas

The four project areas include Area 1, Area 4, Area 9, and Area 10. Area 1 is located in sections 13, 14, 23, and 24 of Township 40N, Range 117W; Area 4 is located in sections 2, 3, 10, and 11 of Township 40N, Range 117W; Area 9 is located in sections 13, and 24 of Township 41N, Range 117W; and Area 10 is located in Sections 5, 6, and 7 of Township 41N, Range 117W (Figure 1). All sites are in Teton County, Wyoming.

Configurations of Management Measures by Project Area

Several management measures are proposed to accomplish the proposed restoration including gravel removal, anchored root wads, brush fences, spur dikes, and rock grade control. Table 1 outlines the techniques proposed for use by project area. A principal feature of all configurations in the construction of brush fences. At each of the four project areas, four alternative designs for the brush fences were evaluated.

Table 1 – Configurations of Management Measures by Project Area							
	Gravel Removal			*Fences*	*Dikes*	*Root Wads*	*Grade Control*
	Channel Capacity	*Side Pools*	*Sediment Traps*				
Area 1		X	X	X		X	
Area 4	X	X	X	X	X	X	
Area 9	X	X		X	X	X	X
Area 10	X	X	X	X	X	X	

The sixteen alternatives are listed in Table 2. The column labeled "Description" indicates the design of brush fence for each alternative.

Table 2 – Alternatives for Economic Analysis	
Name of Economic Analyses	*Description*
Alternative A1	Area 1, 15-year design
Alternative A2	Area 1, 30-year design
Alternative A3	Area 1, 50(a)-year design
Alternative A4	Area 1, 50(b)-year design
Alternative B1	Area 4, 15-year design
Alternative B2	Area 4, 30-year design
Alternative B3	Area 4, 50(a)-year design
Alternative B4	Area 4, 50(b)-year design
Alternative C1	Area 9, 15-year design
Alternative C2	Area 9, 30-year design
Alternative C3	Area 9, 50(a)-year design
Alternative C4	Area 9, 50(b)-year design
Alternative D1	Area 10, 15-year design
Alternative D2	Area 10, 30-year design
Alternative D3	Area 10, 50(a)-year design
Alternative D4	Area 10, 50(b)-year design

Cost of Alternatives

This section provides cost estimates for each of the sixteen alternatives. Cost estimates are broken down by 1) construction costs, 2) real estate, 3) supervisory and administrative costs, 4) preconstruction engineering and design (PED) costs, and 5) operation and maintenance costs. Implementation costs include components for mobilization and demobilization, materials and labor, field and home office overhead, profit, bond, credit for gravel, and contingency. One season is assumed for construction. Annual operation and maintenance costs were developed for gravel removal, site armoring, brush fences, anchored root wads, and bank barbs. Annual O&M costs were applied for each year in the 50-year period of analysis and the resulting O&M cost stream was converted to present values and summed. The following tables summarize the cost estimates for each of the 16 alternatives.

Project Area 1

Table 3 – Cost Estimate for Alternative A1		
Cost Category	*Total*	*Average Annual Equivalent*
Construction Costs	4,734,300	
Real Estate	286,140	
Supervisory & Administrative (6%)	284,058	
PED (9%)	426,087	
TOTAL FIRST COSTS	5,730,585	408,687
O&M	5,703,489	406,754
TOTAL COST	11,434,074	815,441

Table 4 – Cost Estimate for Alternative A2		
Cost Category	*Total*	*Average Annual Equivalent*
Construction Costs	4,726,600	
Real Estate	286,140	
Supervisory & Administrative (6%)	283,596	
PED (9%)	425,394	
TOTAL FIRST COSTS	5,721,730	408,055
O&M	5,687,626	405,623
TOTAL COST	11,409,356	813,678

Table 5 – Cost Estimate for Alternative A3		
Cost Category	*Total*	*Average Annual Equivalent*
Construction Costs	4,795,900	
Real Estate	286,140	
Supervisory & Administrative (6%)	287,754	
PED (9%)	431,631	
TOTAL FIRST COSTS	5,801,425	413,739
O&M	5,676,584	404,835
TOTAL COST	11,478,009	818,574

Table 6 – Cost Estimate for Alternative A4		
Cost Category	*Total*	*Average Annual Equivalent*
Construction Costs	5,849,300	
Real Estate	286,140	
Supervisory & Administrative (6%)	350,958	
PED (9%)	526,437	
TOTAL FIRST COSTS	7,012,835	500,133
O&M	5,714,845	407,564
TOTAL COST	12,727,680	907,697

Project Area 4

Table 7 – Cost Estimate for Alternative B1		
Cost Category	*Total*	*Average Annual Equivalent*
Construction Costs	10,912,800	
Real Estate	99,720	
Supervisory & Administrative (6%)	654,768	
PED (9%)	982,152	
TOTAL FIRST COSTS	12,649,440	902,117
O&M	15,580,390	1,111,143
TOTAL COST	28,229,830	2,013,260

Table 8 – Cost Estimate for Alternative B2		
Cost Category	*Total*	*Average Annual Equivalent*
Construction Costs	10,906,200	
Real Estate	99,720	
Supervisory & Administrative (6%)	654,372	
PED (9%)	981,558	
TOTAL FIRST COSTS	12,641,850	901,576
O&M	15,566,796	1,110,173
TOTAL COST	28,208,646	2,011,749

Table 9 – Cost Estimate for Alternative B3		
Cost Category	*Total*	*Average Annual Equivalent*
Construction Costs	11,086,300	
Real Estate	99,720	
Supervisory & Administrative (6%)	665,178	
PED (9%)	997,767	
TOTAL FIRST COSTS	12,848,965	916,347
O&M	15,557,362	1,109,500
TOTAL COST	28,406,327	2,025,847

Table 10 – Cost Estimate for Alternative B4		
Cost Category	*Total*	*Average Annual Equivalent*
Construction Costs	11,907,400	
Real Estate	99,720	
Supervisory & Administrative (6%)	714,444	
PED (9%)	1,071,666	
TOTAL FIRST COSTS	13,793,230	983,688
O&M	15,587,180	1,111,628
TOTAL COST	29,380,410	2,095,316

Table 11 – Cost Estimate for Alternative C1		
Cost Category	*Total*	*Average Annual Equivalent*
Construction Costs	2,866,000	
Real Estate	67,680	
Supervisory & Administrative (6%)	171,960	
PED (9%)	257,940	
TOTAL FIRST COSTS	3,363,580	239,880
O&M	2,869,853	204,669
TOTAL COST	6,233,433	444,548

Table 12 – Cost Estimate for Alternative C2		
Cost Category	*Total*	*Average Annual Equivalent*
Construction Costs	2,687,600	
Real Estate	67,680	
Supervisory & Administrative (6%)	172,056	
PED (9%)	258,084	
TOTAL FIRST COSTS	3,185,420	227,174
O&M	2,871,761	204,805
TOTAL COST	6,057,181	431,979

Table 13 – Cost Estimate for Alternative C3		
Cost Category	*Total*	*Average Annual Equivalent*
Construction Costs	3,052,500	
Real Estate	67,800	
Supervisory & Administrative (6%)	183,150	
PED (9%)	274,725	
TOTAL FIRST COSTS	3,578,055	255,175
O&M	2,855,718	203,661
TOTAL COST	6,443,773	458,836

Table 14 – Cost Estimate for Alternative C4		
Cost Category	*Total*	*Average Annual Equivalent*
Construction Costs	3,146,500	
Real Estate	67,680	
Supervisory & Administrative (6%)	188,790	
PED (9%)	283,185	
TOTAL FIRST COSTS	3,686,155	262,885
O&M	2,859,113	203,902
TOTAL COST	6,545,268	466,787

Table 15 – Cost Estimate for Alternative D1		
Cost Category	*Total*	*Average Annual Equivalent*
Construction Costs	5,552,400	
Real Estate	100,920	
Supervisory & Administrative (6%)	333,144	
PED (9%)	499,716	
TOTAL FIRST COSTS	6,486,180	462,573
O&M	10,072,638	718,348
TOTAL COST	16,558,818	1,180,921

Table 16 – Cost Estimate for Alternative D2		
Cost Category	*Total*	*Average Annual Equivalent*
Construction Costs	5,563,800	
Real Estate	10,920	
Supervisory & Administrative (6%)	333,828	
PED (9%)	500,742	
TOTAL FIRST COSTS	6,449,290	463,508
O&M	10,062,378	717,616
TOTAL COST	16,561,668	1,181,124

Table 17 – Cost Estimate for Alternative D3		
Cost Category	*Total*	*Average Annual Equivalent*
Construction Costs	5,924,000	
Real Estate	100,920	
Supervisory & Administrative (6%)	355,440	
PED (9%)	533,160	
TOTAL FIRST COSTS	6,913,520	493,050
O&M	10,055,257	717,108
TOTAL COST	16,968,777	1,210,158

Table 18 – Cost Estimate for Alternative D4		
Cost Category	*Total*	*Average Annual Equivalent*
Construction Costs	6,654,500	
Real Estate	100,920	
Supervisory & Administrative (6%)	39,270	
PED (9%)	598,905	
TOTAL FIRST COSTS	7,393,595	527,287
O&M	10,081,771	718,999
TOTAL COST	14,475,366	1,246,286

Environmental Outputs of Alternatives

Two output measures were incorporated into the economic analyses to evaluate the efficiency and effectiveness of the 16 alternatives at achieving environmental restoration objectives: 1) aquatic habitat units, and 2) terrestrial (riparian) habitat units. For each environmental variable, habitat units were estimated for each year in the 50-year period of analysis. The resulting stream of environmental outputs were summed and divided by the number of years in the period of analysis (50) to arrive at average annual habitat units for each alternative. The change in habitat units between the without- and with-project conditions was computed for each alternative to be used as the environmental input for the cost effectiveness and incremental cost analyses. The results of these calculations are summarized in the following tables. For each project area (Project Area 1 = Alternative "A", Project Area 4 = Alternative "B", Project Area 9 = Alternative "C", Project Area 10 = Alternative "D") data is provided for the No-Action Alternative (A0, B0, C0, and D0) and for each of four alternative plans (e.g., A1, A2, A3, or A4).

Calculations were also conducted to identify the percentage change in habitat units for all alternatives. While the absolute "change" in habitat figures gives the appearance that aquatic benefits are much greater than riparian, the "% change" figures indicate that in many cases, relative riparian change from the without-project condition is actually greater. This is because the two output categories were evaluated using different habitat models and the "habitat units" produced by each are not directly comparable units with one another. Aquatic habitat units were measured using a model developed for the Jackson Hole study for Fine Spotted Cutthroat. Riparian habitat units were measured using the U.S. Fish and Wildlife Services' Habitat Evaluation Procedures (HEP) palustrine/forest and shrub scrub models for the Song Sparrow.

Table 19 – Aquatic Habitat Units

Alternative	*Without-Project Average Annual Habitat Units*	*With-Project Average Annual Habitat Units*	*Change*	*% Change*
A0	740.68	1740.68	0	0.0000%
A1	1740.68	1786.72	46.04	2.6449%
A2	1740.68	1786.72	46.04	2.6449%
A3	1740.68	1786.72	46.04	2.6449%
A4	1740.68	1786.72	46.04	2.6449%
B0	4188.8	4188.8	0	0.0000%
B1	4188.8	4351.96	163.16	3.8951%
B2	4188.8	4351.96	163.16	3.8951%
B3	4188.8	4663.96	475.16	11.3436%
B4	4188.8	4663.96	475.16	11.3436%
C0	2193.62	2193.62	0	0.0000%
C1	2193.62	2317.2	123.58	5.6336%
C2	2193.62	2317.2	123.58	5.6336%
C3	2193.62	2785.68	592.06	26.9901%
C4	2193.62	2785.68	592.06	26.9901%
D0	3070.52	3070.52	0	0.0000%
D1	3070.52	3262.32	191.8	6.2465%
D2	3070.52	3262.32	191.8	6.2465%
D3	3070.52	4042.8	972.28	31.6650%
D4	3070.52	4042.8	972.28	31.6650%

Table 20 – Terrestrial (Riparian) Habitat Units				
Alternative	*Without-Project Average Annual Habitat Units*	*With-Project Average Annual Habitat Units*	*Change*	*% Change*
A0	89.08	89.08	0.00	0%
A1	89.08	185.63	96.54	108%
A2	89.08	191.69	102.61	115%
A3	89.08	225.78	136.70	153%
A4	89.08	225.78	136.70	153%
B0	75.47	75.47	0.00	0%
B1	75.47	106.07	30.60	41%
B2	75.47	109.83	34.36	46%
B3	75.47	128.56	53.09	70%
B4	75.47	128.56	53.09	70%
C0	12.73	12.73	0.00	0%
C1	12.73	13.89	1.16	9%
C2	12.73	14.36	1.64	13%
C3	12.73	16.85	4.12	32%
C4	12.73	16.85	4.12	32%
D0	35.87	35.87	0.00	0%
D1	35.87	58.70	22.82	64%
D2	35.87	60.70	24.82	69%
D3	35.87	71.26	35.38	99%
D4	35.87	71.26	35.38	99%

Cost Effectiveness and Incremental Cost Analyses

The cost and output information presented in the previous two sections is the input for cost effectiveness and incremental cost analyses to evaluate the relative effectiveness and efficiency of the different alternatives at producing environmental outputs. Because two different and incommensurate output measures (aquatic and riparian habitat units) were required to assess the holistic effect of alternatives at restoring diverse ecosystem values, two separate analyses were conducted. Each analysis examines the production efficiency of the alternatives for each environmental output category. Following the presentation of results for each environmental category, a comparison is made to identify alternatives that exhibit high performance for the output categories.

To conduct the analyses, the procedures identified in the Corps of Engineers procedures manual for conducting cost effectiveness and incremental cost analyses (IWR Report #95-R-1, USACE, May 1995) were followed. These steps include: 1) display costs and outputs of alternatives, 2) identify combinable alternatives, 3) derive combinations and calculate costs and outputs, 4) identify cost effective plans, 5) calculate and display most efficient alternatives through incremental cost analysis. To facilitate the analysis, the Corps of Engineers software program, IWR-PLAN was used to perform the above steps. The results of the steps are summarized below. First, the analysis for aquatic habitat is presented, followed by the analysis for riparian habitat.

Aquatic Habitat - Display Costs and Outputs of Alternatives

Table 21 provides a display of the costs and outputs associated with each alternative. Both cost and output data are presented as "average annual". While this analysis focuses on aquatic habitat, the riparian output is displayed in the table, as it is still an effect of the alternatives.

Table 21 – Costs and Outputs for All Alternatives

Alternative	*Average Annual Cost*	*Average Annual Aquatic Habitat Units*	*Average Annual Riparian Habitat Units*
A0	$0	0.00	0.00
A1	$815,441	46.04	96.54
A2	$813,678	46.04	102.61
A3	$818,574	46.04	136.70
A4	$907,697	46.04	136.70
B0	$0	0.00	0.00
B1	$2,013,260	163.16	30.60
B2	$2,011,749	163.16	34.36
B3	$2,025,847	475.16	53.09
B4	$2,095,316	475.16	53.09
C0	$0	0.00	0.00
C1	$444,548	123.58	1.16
C2	$431,979	123.58	1.64
C3	$458,836	592.06	4.12
C4	$466,787	592.06	4.12
D0	$0	0.00	0.00
D1	$1,180,921	191.80	22.82
D2	$1,181,124	191.80	24.82
D3	$1,210,158	972.28	35.38
D4	$1,246,286	972.28	35.38

Aquatic Habitat: Identify Combinable Alternatives

Restoration can take place at any of the four project areas (corresponding to Alternatives A, B, C, and D). That is, restoring any one area does not preclude restoration at any other area. Similarly, restoration at any of the areas is not dependent on restoring any other area. However only one of the configurations of measures can be implemented at any on site. For example, at Project Area 1, either A1, A2, A3, or A4 can be implemented but only one.

Aquatic Habitat: Derive Combinations and Calculate Costs and Outputs

The IWR-PLAN software was used to formulate all possible combinations of alternatives for restoring aquatic habitat, resulting in 625 possible combinations of alternatives called "plans" (including the "no-action plan"). Table 22 (provided as Attachment A) displays all the plans with their costs and outputs.

Aquatic Habitat: Identify Cost Effective Plans

Cost effectiveness analysis was next performed to identify those combinations of alternatives that 1) produce the same output as other combinations for less cost, or 2) produce more output than others at the same or less cost. The result was the reduction of the 625 possible combinations to 10 "cost effective" combinations (including the no-action plan). Table 23 displays the cost effective plans with their cost and output.

Table 23 – Aquatic Habitat - Cost Effective Combinations

Plan	Cost	Output
A0B0C0D0	0	0
A0B0C2D0	431,979	123.58
A0B0C3D0	458,836	592.06
A0B0C0D3	1,210,158	972.28
A0B0C2D3	1,642,137	1,095.86
A0B0C3D3	1,668,994	1,564.34
A2B0C3D3	2,482,672	1,610.38
A0B2C3D3	3,680,743	1,727.50
A0B3C3D3	3,694,841	2,039.50
A2B3C3D3	4,508,519	2,085.54

Aquatic Habitat: Incremental Cost Analysis

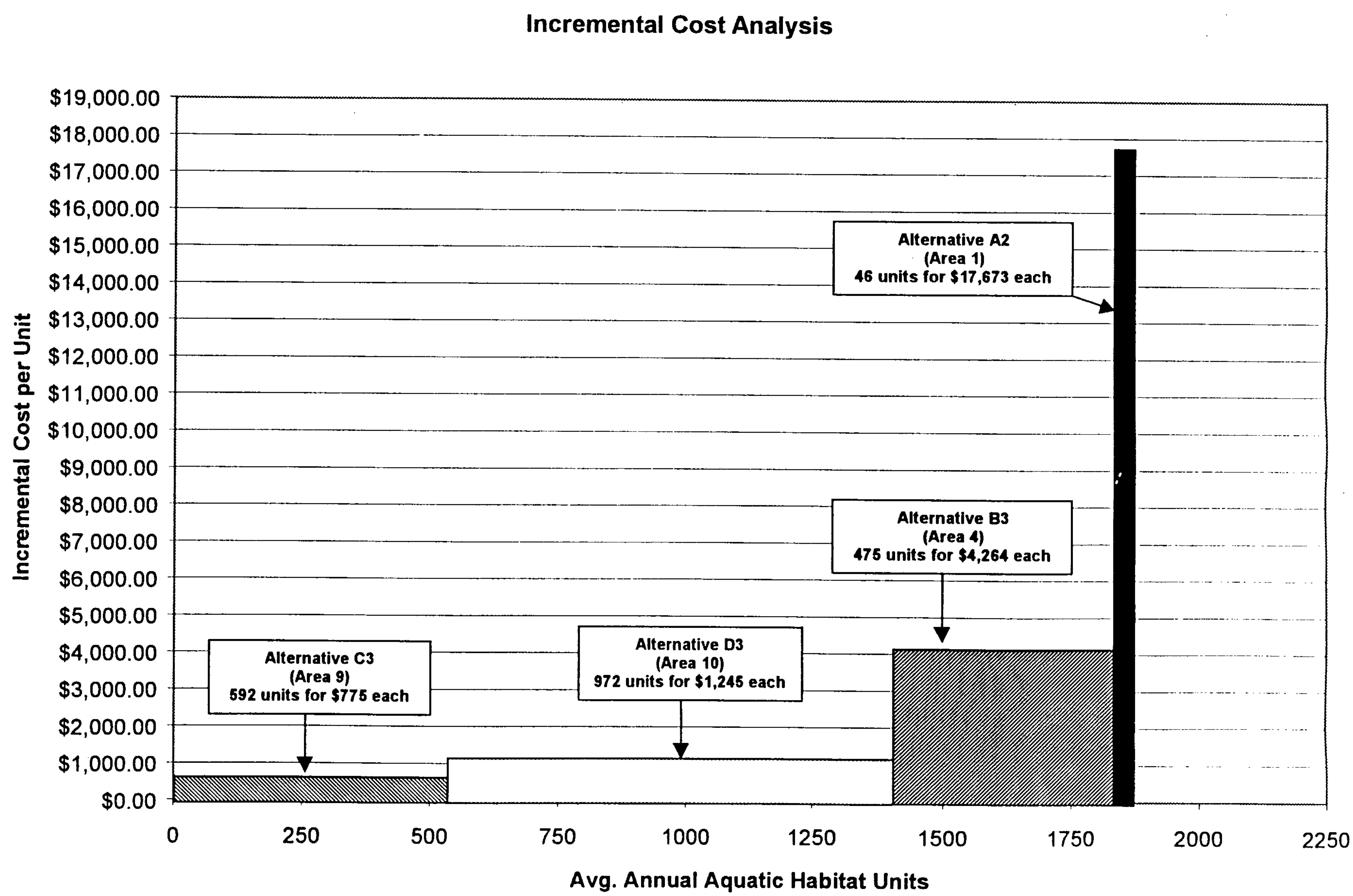
An incremental cost analysis was then conducted to evaluate the changes in cost and output from the no-action plan to all other cost effective plans. The change in cost associated with each plan was divided by the change in output to determine the incremental cost per unit. The "incremental cost per unit" reflects the unit cost of providing additional output over the no action plan. The plan which is identified as having the lowest unit cost of providing additional habitat is sometimes called the "best buy". This best-buy becomes the new baseline to which all larger-output-producing plans are compared to identify the "next-best buy". This iterative process results in the identification of the most efficient set of plans for producing increasing levels of output. The incremental cost analysis identified 5 best-buy plans (including the no-action plan).

Table 24 – Aquatic Habitat: Incremental Cost Analysis (Best Buys)

Plan	*Cost*	*Output*	*Change in Cost*	*Change in Output*	*Incremental Cost per Unit*
A0B0C0D0	$0.00	0	-	-	-
A0B0C3D0	$458,836.00	592.06	$458,836.00	592.06	$775
A0B0C3D3	$1,668,994.00	1564.34	$1,210,158.00	972.28	$1,245
A0B3C3D3	$3,694,841.00	2039.5	$2,025,847.00	475.16	$4,264
A2B3C3D3	$4,508,519.00	2085.54	$813,678.00	46.04	$17,673

The data in Table 24 can be interpreted to support the recommendation of a plan for producing aquatic habitat. If aquatic habitat units are desired, the most efficient alternative available is C3, which provides 592 average annual habitat units at a unit cost of $775 each. If more output is desired, the next-most-efficient alternative is to add D3, which provides 972.28 additional average annual habitat units at a unit cost of $1,245 each. If more output is desired, the next-most-efficient alternative is to add B3, which provides 475 additional average annual habitat units at a unit cost of $4,264 each. If more output is desired, the next-most-efficient alternative is to add A2, which provides 46 additional average annual habitat units at a unit cost of $17,673 each.

The figure on the following page provides a graphical representation of the data in Table 24. Incremental cost per unit is plotted on the vertical axis and output along the horizontal axis. The graph shows relatively small increases in incremental cost per unit from the first alternative (C3) to the next (D3). The increase in incremental cost per unit is larger from D3 to B3, but not as large as the jump in cost to get the last 46 units of output provided by A2.


Incremental Cost Analysis
Incremental Cost per Unit
$19,000.00
$18,000.00
$17,000.00
$16,000.00
$15,000.00
$14,000.00
$13,000.00
$12,000.00
$11,000.00
$10,000.00
$9,000.00
$8,000.00
$7,000.00
$6,000.00
$5,000.00
$4,000.00
$3,000.00
$2,000.00
$1,000.00
$0.00
Alternative A2 (Area 1) 46 units for $17,673 each
Alternative B3 (Area 4) 475 units for $4,264 each
Alternative C3 (Area 9) 592 units for $775 each
Alternative D3 (Area 10) 972 units for $1,245 each
0
250
500
750
1000
1250
1500
1750
2000
2250
Avg. Annual Aquatic Habitat Units

Riparian Habitat - Display Costs and Outputs of Alternatives

Table 25 provides a display of the costs and outputs associated with each alternative. Both cost and output data are presented as "average annual". While this analysis focuses on riparian habitat, the aquatic output is displayed in the table, as it is still an effect of the alternatives.

Table 25 – Costs and Outputs for All Alternatives

Alternative	*Average Annual Cost*	*Average Annual Riparian Habitat Units*	*Average Annual Aquatic Habitat Units*
A0	$0	0.00	0.00
A1	$815,441	96.54	46.04
A2	$813,678	102.61	46.04
A3	$818,574	136.70	46.04
A4	$907,697	136.70	46.04
B0	$0	0.00	0.00
B1	$2,013,260	30.60	163.16
B2	$2,011,749	34.36	163.16
B3	$2,025,847	53.09	475.16
B4	$2,095,316	53.09	475.16
C0	$0	0	0.00
C1	$444,548	1.16	123.58
C2	$431,979	1.64	123.58
C3	$458,836	4.12	592.06
C4	$466,787	4.12	592.06
D0	$0	0	0.00
D1	$1,180,921	22.82	191.80
D2	$1,181,124	24.82	191.80
D3	$1,210,158	35.38	972.28
D4	$1,246,286	35.38	972.28

Riparian: Identify Combinable Alternatives

Restoration can take place at any of the four project areas (corresponding to Alternatives A, B, C, and D). That is, restoring any one area does not preclude restoration at any other area. Similarly, restoration at any of the areas is not dependent on restoring any other area. However only one of the configurations of measures can be implemented at any on site. For example, at Project Area 1, either A1, A2, A3, or A4 can be implemented but only one.

Riparian: Derive Combinations and Calculate Costs and Outputs

The IWR-PLAN software was used to formulate all possible combinations of alternatives for restoring aquatic habitat, resulting in 625 possible combinations of alternatives called "plans" (including the "no-action plan"). Table 26 (provided as Attachment B) displays the combinations with their costs and outputs.

Riparian: Identify Cost Effective Plans

Cost effectiveness analysis was next performed to identify those combinations of alternatives that 1) produce the same output as other combinations for less cost, or 2) produce more output than others at the same or less cost. The result was the reduction of the 625 possible combinations to 21 "cost effective" combinations (including the no-action plan). Table 27 displays the cost effective plans with their cost and output.

Table 27 –Riparian Habitat - Cost Effective Combinations

Plan				*Cost*	*Output*
A0	B0	C0	D0	0	0.00
A0	B0	C2	D0	431,979	1.64
A0	B0	C3	D0	458,836	4.12
A2	B0	C0	D0	813,678	102.61
A3	B0	C0	D0	818,574	136.70
A3	B0	C2	D0	1,250,553	138.34
A3	B0	C3	D0	1,277,410	140.82
A3	B0	C0	D1	1,999,495	159.52
A3	B0	C0	D2	1,999,698	161.52
A3	B0	C0	D3	2,028,732	172.08
A3	B0	C2	D3	2,460,711	173.72
A3	B0	C3	D3	2,487,568	176.20
A3	B3	C0	D0	2,844,421	189.79
A3	B3	C2	D0	3,276,400	191.43
A3	B3	C3	D0	3,303,257	193.91
A3	B2	C0	D2	4,011,447	195.88
A3	B3	C0	D1	4,025,342	212.61
A3	B3	C0	D2	4,025,545	214.61
A3	B3	C0	D3	4,054,579	225.17
A3	B3	C2	D3	4,486,558	226.81
A3	B3	C3	D3	4,513,415	229.29

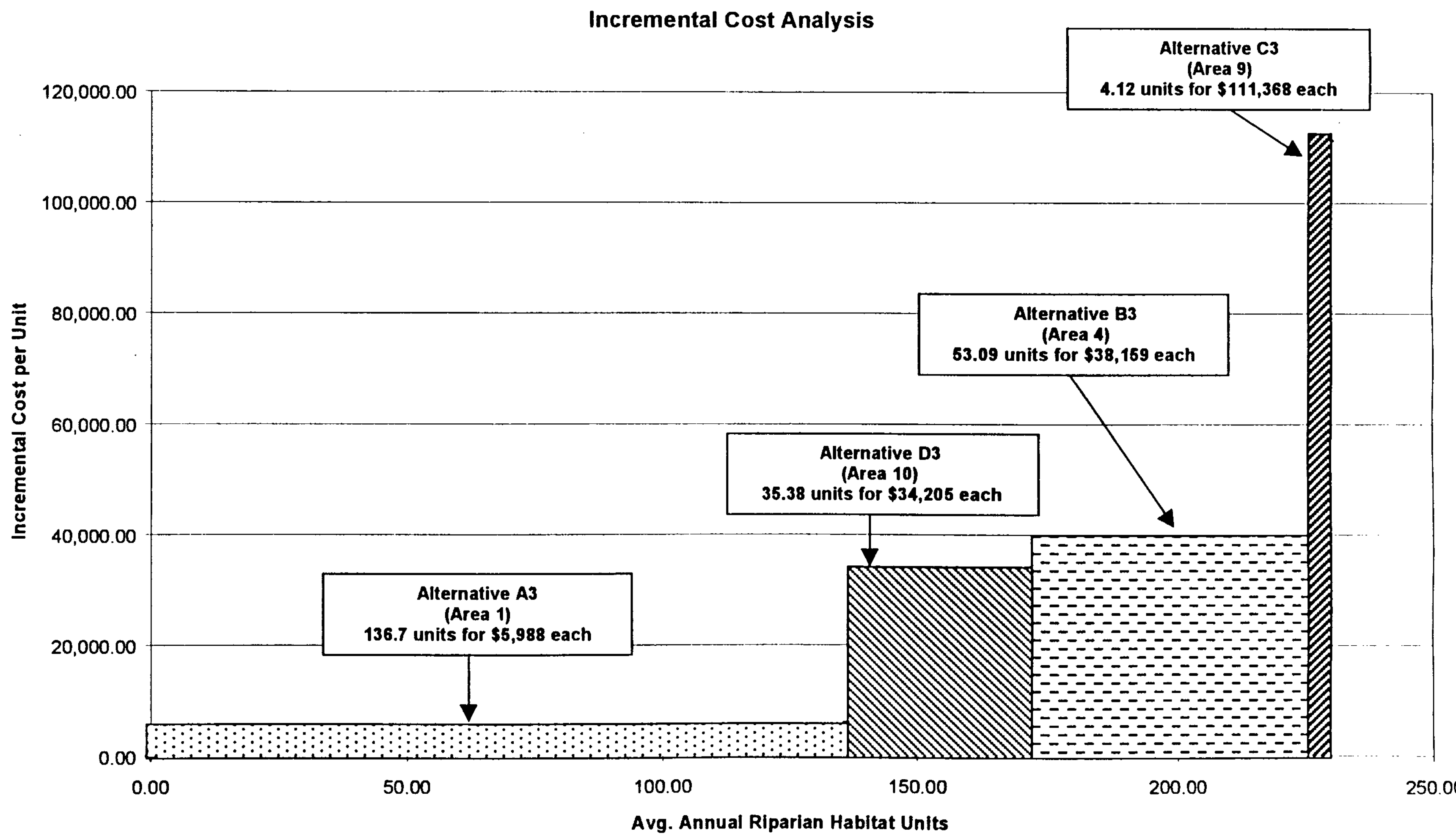
Riparian: Incremental Cost Analysis

An incremental cost analysis was then conducted to evaluate the changes in cost and output from the no-action plan to all other cost effective plans. The change in cost associated with each plan was divided by the change in output to determine the incremental cost per unit. The "incremental cost per unit" reflects the unit cost of providing additional output over the no action plan. The plan which is identified as having the lowest unit cost of providing additional habitat is sometimes called the "best buy". This best-buy becomes the new baseline to which all larger-output-producing plans are compared to identify the "next-best buy". This iterative process results in the identification of the most efficient set of plans for producing increasing levels of output. The incremental cost analysis identified 5 best-buy plans (including the no-action plan).

Table 28 – Riparian Habitat: Incremental Cost Analysis (Best Buys)									
Plan				Cost	Output	Change in Cost	Change in Output	Incremental Cost per Unit
A0	B0	C0	D0	0	0.00	0	0.00	0
A3	B0	C0	D0	818,574	136.70	818,574	136.70	5,988
A3	B0	C0	D3	2,028,732	172.08	1,210,158	35.38	34,205
A3	B3	C0	D3	4,054,579	225.17	2,025,847	53.09	38,159
A3	B3	C3	D3	4,513,415	229.29	458,836	4.12	111,368

The data in Table 28 can be interpreted to support the recommendation of a plan for producing riparian habitat. If riparian habitat units are desired, the most efficient alternative available is A3, which provides 136.70 average annual habitat units at a unit cost of $5,988 each. If more output is desired, the next-most-efficient alternative is to add D3, which provides 35.38 additional average annual habitat units at a unit cost of $34,205 each. If more output is desired, the next-most-efficient alternative is to add B3, which provides 53.09 additional average annual habitat units at a unit cost of $38,159 each. If more output is desired, the next-most-efficient alternative is to add C3, which provides 4.12 additional average annual habitat units at a unit cost of $111,368 each.

The figure on the following page provides a graphical representation of the data in Table 28. Incremental cost per unit is plotted on the vertical axis and output along the horizontal axis. The graph shows a large return for investment with A3 (Area 1), then a jump in incremental cost per unit to get to the next alternatives (B3 and D3), which each provide significant output for similar incremental cost per unit. A significant increase in incremental cost per unit comes as Alternative C3 is implemented. This is largely due to the relatively small change in riparian output with the alternative. While C3 ranks last in riparian habitat production efficiency, this is in large part due to the riparian habitat demonstration project that has already been completed at Site 9 and factored into the without project analysis. Further examination should be conducted to determine if implementing the aquatic habitat restoration features at Site 9 would provide for sustainability of benefits to be provided by the Site 9 demonstration project.


Incremental Cost Analysis
Alternative C3
(Area 9)
4.12 units for $111,368 each
Alternative B3
(Area 4)
53.09 units for $38,159 each
Alternative D3
(Area 10)
35.38 units for $34,205 each
Alternative A3
(Area 1)
136.7 units for $5,988 each
Incremental Cost per Unit
120,000.00
100,000.00
80,000.00
60,000.00
40,000.00
20,000.00
0.00
0.00
50.00
100.00
150.00
200.00
250.00
Avg. Annual Riparian Habitat Units

Uncertainty Analysis

To examine the effect of uncertainty in cost and output estimates on the analyses, an analysis was conducted that evaluated the implications of 20% uncertainty in cost estimates and 20% uncertainty in output estimates. All cost and output estimates for all 625 possible combinations were adjusted to reflect plus and minus 20%. A "best-case" scenario using the -20% adjusted cost estimates and the +20% adjusted output estimates was then analyzed for both aquatic and riparian output types. Similarly, a "worst-case" scenario was analyzed using +20% adjusted cost estimates and –20% adjusted output estimates. The results of these sensitivity analyses provided very similar results as presented in the previous sections. In both the best- and worst- case scenarios, the ranking of best-buys was the same as described in the previous section, indicating that data uncertainty in the + or – 20% range should not have a significant impact on the results.

Cross-Comparison of Aquatic and Riparian Costs and Benefits

Because the project required two analyses, one for aquatic restoration and one for riparian restoration, a comparison of results was conducted to identify any plans that may be particularly effective and efficient at producing both types of outputs. This comparison is summarized in Table 29. Table 29 lists the alternatives that were found to be best-buys for either output type. For each alternative, cost, aquatic habitat units, riparian habitat units, and incremental cost per unit for both habitat types are presented. In addition the table indicates if each alternative was found to be 1) cost effective for either habitat type, and 2) a best-buy for either habitat type. In the columns that identify if alternatives were determined to be best-buys, a number in parentheses indicates the rank of the best buy. For example, a "1" indicates that the alternative was the most efficient at producing that output type, a "2" was the next most efficient, and so on.

Table 29 – Cross Comparison of Aquatic and Riparian Costs and Benefits

Evaluation Criteria	Alternative				
	D3 *(Site 10)*	*B3 (Site 4)*	*C3 (Site 9)*	*A3* (Site 1)*	*A2* (Site 1)*
Cost	$1,210,158	$2,025,847	$458,836	$818,574	$813,678
Aquatic Output	972.28	475.16	592.00	46.04	46.04
Inc. Cost per Unit of Aquatic	$1,244	$4,263	$775	--	$17,673
Riparian Output	35.38	53.09	4.12	136.70	102.61
Inc. Cost per Unit of Riparian	$34,205	$38,159	$111,368	$5,988	--
Cost Effective for Aquatic	X	X	X		X
Cost Effective for Riparian	X	X	X	X	
Best Buy for Aquatic (Rank out of 4)	X(2)	X(3)	X(1)	--	X(4)
Best Buy for Riparian (Rank out of 4)	X(2)	X(3)	X(4)	X(1)	--

**Alternative A3 was identified as the first best buy for riparian but was found to be non-cost effective for aquatic because A2 provided the same aquatic output as A3 for approximately $5,000 less. Due to the closeness in cost of A3 and A2, and A2s A2 is set aside and A3 is carried forward for possible recommendation.*

Conclusions

Based upon the cost effectiveness and incremental cost analyses and the comparison of aquatic and riparian costs and benefits, if appears that Alternative D3 at Site 10 is the most efficient option for producing both habitat types, ranking second in efficiency for riparian habitat and second for aquatic. Alternative B3 at Site 4 should be considered for recommendation as it is the third most efficient for riparian and the third most efficient for aquatic. Alternative A3 at Site 1 is clearly the most efficient for riparian but is the least efficient for aquatic. Similarly, Alternative C3 at Site 9 is the most efficient for aquatic although it is the least efficient for riparian. Both these sites could be recommended for incorporation into a holistic ecosystem restoration plan for the study area based upon the results of the cost effectiveness analysis. The economic analysis supports the recommendation of plan A3 B3 C3 D3 as the National Ecosystem Restoration Plan for the Jackson Hole study. This plan includes the fifty-year sheet pile fence design, channel excavation, and in some sites construction of spur dikes in Project Areas 1, 4, 9, and 10.

ATTACHMENT A
All Combinations of Alternative Management Measures (Aquatic):

Table 22 – Aquatic Habitat: All Combinations of Alternatives with Cost and Output					
Plan				*Cost*	*Output*
A0	B0	C0	D0	0	0.00
A2	B0	C0	D0	813,678	46.04
A1	B0	C0	D0	815,441	46.04
A3	B0	C0	D0	818,574	46.04
A4	B0	C0	D0	907,697	46.04
A0	B0	C2	D0	431,979	123.58
A0	B0	C1	D0	444,548	123.58
A0	B2	C0	D0	2,011,749	163.16
A0	B1	C0	D0	2,013,260	163.16
A2	B0	C2	D0	1,245,657	169.62
A1	B0	C2	D0	1,247,420	169.62
A3	B0	C2	D0	1,250,553	169.62
A2	B0	C1	D0	1,258,226	169.62
A1	B0	C1	D0	1,259,989	169.62
A3	B0	C1	D0	1,263,122	169.62
A4	B0	C2	D0	1,339,676	169.62
A4	B0	C1	D0	1,352,245	169.62
A0	B0	C0	D1	1,180,921	191.80
A0	B0	C0	D2	1,181,124	191.80
A2	B2	C0	D0	2,825,427	209.20
A2	B1	C0	D0	2,826,938	209.20
A1	B2	C0	D0	2,827,190	209.20
A1	B1	C0	D0	2,828,701	209.20
A3	B2	C0	D0	2,830,323	209.20
A3	B1	C0	D0	2,831,834	209.20
A4	B2	C0	D0	2,919,446	209.20
A4	B1	C0	D0	2,920,957	209.20
A2	B0	C0	D1	1,994,599	237.84
A2	B0	C0	D2	1,994,802	237.84
A1	B0	C0	D1	1,996,362	237.84
A1	B0	C0	D2	1,996,565	237.84
A3	B0	C0	D1	1,999,495	237.84
A3	B0	C0	D2	1,999,698	237.84
A4	B0	C0	D1	2,088,618	237.84
A4	B0	C0	D2	2,088,821	237.84
A0	B2	C2	D0	2,443,728	286.74
A0	B1	C2	D0	2,445,239	286.74
A0	B2	C1	D0	2,456,297	286.74
A0	B1	C1	D0	2,457,808	286.74
A0	B0	C2	D1	1,612,900	315.38
A0	B0	C2	D2	1,613,103	315.38
A0	B0	C1	D1	1,625,469	315.38
A0	B0	C1	D2	1,625,672	315.38
A2	B2	C2	D0	3,257,406	332.78
A2	B1	C2	D0	3,258,917	332.78

Table 22 – Aquatic Habitat: All Combinations of Alternatives with Cost and Output					
Plan				*Cost*	*Output*
A1	B2	C2	D0	3,259,169	332.78
A1	B1	C2	D0	3,260,680	332.78
A3	B2	C2	D0	3,262,302	332.78
A3	B1	C2	D0	3,263,813	332.78
A2	B2	C1	D0	3,269,975	332.78
A2	B1	C1	D0	3,271,486	332.78
A1	B2	C1	D0	3,271,738	332.78
A1	B1	C1	D0	3,273,249	332.78
A3	B2	C1	D0	3,274,871	332.78
A3	B1	C1	D0	3,276,382	332.78
A4	B2	C2	D0	3,351,425	332.78
A4	B1	C2	D0	3,352,936	332.78
A4	B2	C1	D0	3,363,994	332.78
A4	B1	C1	D0	3,365,505	332.78
A0	B2	C0	D1	3,192,670	354.96
A0	B2	C0	D2	3,192,873	354.96
A0	B1	C0	D1	3,194,181	354.96
A0	B1	C0	D2	3,194,384	354.96
A2	B0	C2	D1	2,426,578	361.42
A2	B0	C2	D2	2,426,781	361.42
A1	B0	C2	D1	2,428,341	361.42
A1	B0	C2	D2	2,428,544	361.42
A3	B0	C2	D1	2,431,474	361.42
A3	B0	C2	D2	2,431,677	361.42
A2	B0	C1	D1	2,439,147	361.42
A2	B0	C1	D2	2,439,350	361.42
A1	B0	C1	D1	2,440,910	361.42
A1	B0	C1	D2	2,441,113	361.42
A3	B0	C1	D1	2,444,043	361.42
A3	B0	C1	D2	2,444,246	361.42
A4	B0	C2	D1	2,520,597	361.42
A4	B0	C2	D2	2,520,800	361.42
A4	B0	C1	D1	2,533,166	361.42
A4	B0	C1	D2	2,533,369	361.42
A2	B2	C0	D1	4,006,348	401.00
A2	B2	C0	D2	4,006,551	401.00
A2	B1	C0	D1	4,007,859	401.00
A2	B1	C0	D2	4,008,062	401.00
A1	B2	C0	D1	4,008,111	401.00
A1	B2	C0	D2	4,008,314	401.00
A1	B1	C0	D1	4,009,622	401.00
A1	B1	C0	D2	4,009,825	401.00
A3	B2	C0	D1	4,011,244	401.00
A3	B2	C0	D2	4,011,447	401.00
A3	B1	C0	D1	4,012,755	401.00
A3	B1	C0	D2	4,012,958	401.00
A4	B2	C0	D1	4,100,367	401.00
A4	B2	C0	D2	4,100,570	401.00
A4	B1	C0	D1	4,101,878	401.00
A4	B1	C0	D2	4,102,081	401.00

Table 22 – Aquatic Habitat: All Combinations of Alternatives with Cost and Output					
Plan				*Cost*	*Output*
A0	B3	C0	D0	2,025,847	475.16
A0	B4	C0	D0	2,095,316	475.16
A0	B2	C2	D1	3,624,649	478.54
A0	B2	C2	D2	3,624,852	478.54
A0	B1	C2	D1	3,626,160	478.54
A0	B1	C2	D2	3,626,363	478.54
A0	B2	C1	D1	3,637,218	478.54
A0	B2	C1	D2	3,637,421	478.54
A0	B1	C1	D1	3,638,729	478.54
A0	B1	C1	D2	3,638,932	478.54
A2	B3	C0	D0	2,839,525	521.20
A1	B3	C0	D0	2,841,288	521.20
A3	B3	C0	D0	2,844,421	521.20
A2	B4	C0	D0	2,908,994	521.20
A1	B4	C0	D0	2,910,757	521.20
A3	B4	C0	D0	2,913,890	521.20
A4	B3	C0	D0	2,933,544	521.20
A4	B4	C0	D0	3,003,013	521.20
A2	B2	C2	D1	4,438,327	524.58
A2	B2	C2	D2	4,438,530	524.58
A2	B1	C2	D1	4,439,838	524.58
A2	B1	C2	D2	4,440,041	524.58
A1	B2	C2	D1	4,440,090	524.58
A1	B2	C2	D2	4,440,293	524.58
A1	B1	C2	D1	4,441,601	524.58
A1	B1	C2	D2	4,441,804	524.58
A3	B2	C2	D1	4,443,223	524.58
A3	B2	C2	D2	4,443,426	524.58
A3	B1	C2	D1	4,444,734	524.58
A3	B1	C2	D2	4,444,937	524.58
A2	B2	C1	D1	4,450,896	524.58
A2	B2	C1	D2	4,451,099	524.58
A2	B1	C1	D1	4,452,407	524.58
A2	B1	C1	D2	4,452,610	524.58
A1	B2	C1	D1	4,452,659	524.58
A1	B2	C1	D2	4,452,862	524.58
A1	B1	C1	D1	4,454,170	524.58
A1	B1	C1	D2	4,454,373	524.58
A3	B2	C1	D1	4,455,792	524.58
A3	B2	C1	D2	4,455,995	524.58
A3	B1	C1	D1	4,457,303	524.58
A3	B1	C1	D2	4,457,506	524.58
A4	B2	C2	D1	4,532,346	524.58
A4	B2	C2	D2	4,532,549	524.58
A4	B1	C2	D1	4,533,857	524.58
A4	B1	C2	D2	4,534,060	524.58
A4	B2	C1	D1	4,544,915	524.58
A4	B2	C1	D2	4,545,118	524.58
A4	B1	C1	D1	4,546,426	524.58
A4	B1	C1	D2	4,546,629	524.58

Table 22 – Aquatic Habitat: All Combinations of Alternatives with Cost and Output					
Plan				*Cost*	*Output*
A0	B0	C3	D0	458,836	592.06
A0	B0	C4	D0	466,787	592.06
A0	B3	C2	D0	2,457,826	598.74
A0	B3	C1	D0	2,470,395	598.74
A0	B4	C2	D0	2,527,295	598.74
A0	B4	C1	D0	2,539,864	598.74
A2	B0	C3	D0	1,272,514	638.10
A1	B0	C3	D0	1,274,277	638.10
A3	B0	C3	D0	1,277,410	638.10
A2	B0	C4	D0	1,280,465	638.10
A1	B0	C4	D0	1,282,228	638.10
A3	B0	C4	D0	1,285,361	638.10
A4	B0	C3	D0	1,366,533	638.10
A4	B0	C4	D0	1,374,484	638.10
A2	B3	C2	D0	3,271,504	644.78
A1	B3	C2	D0	3,273,267	644.78
A3	B3	C2	D0	3,276,400	644.78
A2	B3	C1	D0	3,284,073	644.78
A1	B3	C1	D0	3,285,836	644.78
A3	B3	C1	D0	3,288,969	644.78
A2	B4	C2	D0	3,340,973	644.78
A1	B4	C2	D0	3,342,736	644.78
A3	B4	C2	D0	3,345,869	644.78
A2	B4	C1	D0	3,353,542	644.78
A1	B4	C1	D0	3,355,305	644.78
A3	B4	C1	D0	3,358,438	644.78
A4	B3	C2	D0	3,365,523	644.78
A4	B3	C1	D0	3,378,092	644.78
A4	B4	C2	D0	3,434,992	644.78
A4	B4	C1	D0	3,447,561	644.78
A0	B3	C0	D1	3,206,768	666.96
A0	B3	C0	D2	3,206,971	666.96
A0	B4	C0	D1	3,276,237	666.96
A0	B4	C0	D2	3,276,440	666.96
A2	B3	C0	D1	4,020,446	713.00
A2	B3	C0	D2	4,020,649	713.00
A1	B3	C0	D1	4,022,209	713.00
A1	B3	C0	D2	4,022,412	713.00
A3	B3	C0	D1	4,025,342	713.00
A3	B3	C0	D2	4,025,545	713.00
A2	B4	C0	D1	4,089,915	713.00
A2	B4	C0	D2	4,090,118	713.00
A1	B4	C0	D1	4,091,678	713.00
A1	B4	C0	D2	4,091,881	713.00
A3	B4	C0	D1	4,094,811	713.00
A3	B4	C0	D2	4,095,014	713.00
A4	B3	C0	D1	4,114,465	713.00
A4	B3	C0	D2	4,114,668	713.00
A4	B4	C0	D1	4,183,934	713.00
A4	B4	C0	D2	4,184,137	713.00

Table 22 – Aquatic Habitat: All Combinations of Alternatives with Cost and Output					
Plan				*Cost*	*Output*
A0	B2	C3	D0	2,470,585	755.22
A0	B1	C3	D0	2,472,096	755.22
A0	B2	C4	D0	2,478,536	755.22
A0	B1	C4	D0	2,480,047	755.22
A0	B0	C3	D1	1,639,757	783.86
A0	B0	C3	D2	1,639,960	783.86
A0	B0	C4	D1	1,647,708	783.86
A0	B0	C4	D2	1,647,911	783.86
A0	B3	C2	D1	3,638,747	790.54
A0	B3	C2	D2	3,638,950	790.54
A0	B3	C1	D1	3,651,316	790.54
A0	B3	C1	D2	3,651,519	790.54
A0	B4	C2	D1	3,708,216	790.54
A0	B4	C2	D2	3,708,419	790.54
A0	B4	C1	D1	3,720,785	790.54
A0	B4	C1	D2	3,720,988	790.54
A2	B2	C3	D0	3,284,263	801.26
A2	B1	C3	D0	3,285,774	801.26
A1	B2	C3	D0	3,286,026	801.26
A1	B1	C3	D0	3,287,537	801.26
A3	B2	C3	D0	3,289,159	801.26
A3	B1	C3	D0	3,290,670	801.26
A2	B2	C4	D0	3,292,214	801.26
A2	B1	C4	D0	3,293,725	801.26
A1	B2	C4	D0	3,293,977	801.26
A1	B1	C4	D0	3,295,488	801.26
A3	B2	C4	D0	3,297,110	801.26
A3	B1	C4	D0	3,298,621	801.26
A4	B2	C3	D0	3,378,282	801.26
A4	B1	C3	D0	3,379,793	801.26
A4	B2	C4	D0	3,386,233	801.26
A4	B1	C4	D0	3,387,744	801.26
A2	B0	C3	D1	2,453,435	829.90
A2	B0	C3	D2	2,453,638	829.90
A1	B0	C3	D1	2,455,198	829.90
A1	B0	C3	D2	2,455,401	829.90
A3	B0	C3	D1	2,458,331	829.90
A3	B0	C3	D2	2,458,534	829.90
A2	B0	C4	D1	2,461,386	829.90
A2	B0	C4	D2	2,461,589	829.90
A1	B0	C4	D1	2,463,149	829.90
A1	B0	C4	D2	2,463,352	829.90
A3	B0	C4	D1	2,466,282	829.90
A3	B0	C4	D2	2,466,485	829.90
A4	B0	C3	D1	2,547,454	829.90
A4	B0	C3	D2	2,547,657	829.90
A4	B0	C4	D1	2,555,405	829.90
A4	B0	C4	D2	2,555,608	829.90
A2	B3	C2	D1	4,452,425	836.58
A2	B3	C2	D2	4,452,628	836.58

Table 22 – Aquatic Habitat: All Combinations of Alternatives with Cost and Output					
Plan				Cost	Output
A1	B3	C2	D1	4,454,188	836.58
A1	B3	C2	D2	4,454,391	836.58
A3	B3	C2	D1	4,457,321	836.58
A3	B3	C2	D2	4,457,524	836.58
A2	B3	C1	D1	4,464,994	836.58
A2	B3	C1	D2	4,465,197	836.58
A1	B3	C1	D1	4,466,757	836.58
A1	B3	C1	D2	4,466,960	836.58
A3	B3	C1	D1	4,469,890	836.58
A3	B3	C1	D2	4,470,093	836.58
A2	B4	C2	D1	4,521,894	836.58
A2	B4	C2	D2	4,522,097	836.58
A1	B4	C2	D1	4,523,657	836.58
A1	B4	C2	D2	4,523,860	836.58
A3	B4	C2	D1	4,526,790	836.58
A3	B4	C2	D2	4,526,993	836.58
A2	B4	C1	D1	4,534,463	836.58
A2	B4	C1	D2	4,534,666	836.58
A1	B4	C1	D1	4,536,226	836.58
A1	B4	C1	D2	4,536,429	836.58
A3	B4	C1	D1	4,539,359	836.58
A3	B4	C1	D2	4,539,562	836.58
A4	B3	C2	D1	4,546,444	836.58
A4	B3	C2	D2	4,546,647	836.58
A4	B3	C1	D1	4,559,013	836.58
A4	B3	C1	D2	4,559,216	836.58
A4	B4	C2	D1	4,615,913	836.58
A4	B4	C2	D2	4,616,116	836.58
A4	B4	C1	D1	4,628,482	836.58
A4	B4	C1	D2	4,628,685	836.58
A0	B2	C3	D1	3,651,506	947.02
A0	B2	C3	D2	3,651,709	947.02
A0	B1	C3	D1	3,653,017	947.02
A0	B1	C3	D2	3,653,220	947.02
A0	B2	C4	D1	3,659,457	947.02
A0	B2	C4	D2	3,659,660	947.02
A0	B1	C4	D1	3,660,968	947.02
A0	B1	C4	D2	3,661,171	947.02
A0	B0	C0	D3	1,210,158	972.28
A0	B0	C0	D4	1,246,286	972.28
A2	B2	C3	D1	4,465,184	993.06
A2	B2	C3	D2	4,465,387	993.06
A2	B1	C3	D1	4,466,695	993.06
A2	B1	C3	D2	4,466,898	993.06
A1	B2	C3	D1	4,466,947	993.06
A1	B2	C3	D2	4,467,150	993.06
A1	B1	C3	D1	4,468,458	993.06
A1	B1	C3	D2	4,468,661	993.06
A3	B2	C3	D1	4,470,080	993.06
A3	B2	C3	D2	4,470,283	993.06

Table 22 – Aquatic Habitat: All Combinations of Alternatives with Cost and Output					
Plan				*Cost*	*Output*
A3	B1	C3	D1	4,471,591	993.06
A3	B1	C3	D2	4,471,794	993.06
A2	B2	C4	D1	4,473,135	993.06
A2	B2	C4	D2	4,473,338	993.06
A2	B1	C4	D1	4,474,646	993.06
A2	B1	C4	D2	4,474,849	993.06
A1	B2	C4	D1	4,474,898	993.06
A1	B2	C4	D2	4,475,101	993.06
A1	B1	C4	D1	4,476,409	993.06
A1	B1	C4	D2	4,476,612	993.06
A3	B2	C4	D1	4,478,031	993.06
A3	B2	C4	D2	4,478,234	993.06
A3	B1	C4	D1	4,479,542	993.06
A3	B1	C4	D2	4,479,745	993.06
A4	B2	C3	D1	4,559,203	993.06
A4	B2	C3	D2	4,559,406	993.06
A4	B1	C3	D1	4,560,714	993.06
A4	B1	C3	D2	4,560,917	993.06
A4	B2	C4	D1	4,567,154	993.06
A4	B2	C4	D2	4,567,357	993.06
A4	B1	C4	D1	4,568,665	993.06
A4	B1	C4	D2	4,568,868	993.06
A2	B0	C0	D3	2,023,836	1018.32
A1	B0	C0	D3	2,025,599	1018.32
A3	B0	C0	D3	2,028,732	1018.32
A2	B0	C0	D4	2,059,964	1018.32
A1	B0	C0	D4	2,061,727	1018.32
A3	B0	C0	D4	2,064,860	1018.32
A4	B0	C0	D3	2,117,855	1018.32
A4	B0	C0	D4	2,153,983	1018.32
A0	B3	C3	D0	2,484,683	1067.22
A0	B3	C4	D0	2,492,634	1067.22
A0	B4	C3	D0	2,554,152	1067.22
A0	B4	C4	D0	2,562,103	1067.22
A0	B0	C2	D3	1,642,137	1095.86
A0	B0	C1	D3	1,654,706	1095.86
A0	B0	C2	D4	1,678,265	1095.86
A0	B0	C1	D4	1,690,834	1095.86
A2	B3	C3	D0	3,298,361	1113.26
A1	B3	C3	D0	3,300,124	1113.26
A3	B3	C3	D0	3,303,257	1113.26
A2	B3	C4	D0	3,306,312	1113.26
A1	B3	C4	D0	3,308,075	1113.26
A3	B3	C4	D0	3,311,208	1113.26
A2	B4	C3	D0	3,367,830	1113.26
A1	B4	C3	D0	3,369,593	1113.26
A3	B4	C3	D0	3,372,726	1113.26
A2	B4	C4	D0	3,375,781	1113.26
A1	B4	C4	D0	3,377,544	1113.26
A3	B4	C4	D0	3,380,677	1113.26

Table 22 – Aquatic Habitat: All Combinations of Alternatives with Cost and Output					
Plan				*Cost*	*Output*
A4	B3	C3	D0	3,392,380	1113.26
A4	B3	C4	D0	3,400,331	1113.26
A4	B4	C3	D0	3,461,849	1113.26
A4	B4	C4	D0	3,469,800	1113.26
A0	B2	C0	D3	3,221,907	1135.44
A0	B1	C0	D3	3,223,418	1135.44
A0	B2	C0	D4	3,258,035	1135.44
A0	B1	C0	D4	3,259,546	1135.44
A2	B0	C2	D3	2,455,815	1141.90
A1	B0	C2	D3	2,457,578	1141.90
A3	B0	C2	D3	2,460,711	1141.90
A2	B0	C1	D3	2,468,384	1141.90
A1	B0	C1	D3	2,470,147	1141.90
A3	B0	C1	D3	2,473,280	1141.90
A2	B0	C2	D4	2,491,943	1141.90
A1	B0	C2	D4	2,493,706	1141.90
A3	B0	C2	D4	2,496,839	1141.90
A2	B0	C1	D4	2,504,512	1141.90
A1	B0	C1	D4	2,506,275	1141.90
A3	B0	C1	D4	2,509,408	1141.90
A4	B0	C2	D3	2,549,834	1141.90
A4	B0	C1	D3	2,562,403	1141.90
A4	B0	C2	D4	2,585,962	1141.90
A4	B0	C1	D4	2,598,531	1141.90
A2	B2	C0	D3	4,035,585	1181.48
A2	B1	C0	D3	4,037,096	1181.48
A1	B2	C0	D3	4,037,348	1181.48
A1	B1	C0	D3	4,038,859	1181.48
A3	B2	C0	D3	4,040,481	1181.48
A3	B1	C0	D3	4,041,992	1181.48
A2	B2	C0	D4	4,071,713	1181.48
A2	B1	C0	D4	4,073,224	1181.48
A1	B2	C0	D4	4,073,476	1181.48
A1	B1	C0	D4	4,074,987	1181.48
A3	B2	C0	D4	4,076,609	1181.48
A3	B1	C0	D4	4,078,120	1181.48
A4	B2	C0	D3	4,129,604	1181.48
A4	B1	C0	D3	4,131,115	1181.48
A4	B2	C0	D4	4,165,732	1181.48
A4	B1	C0	D4	4,167,243	1181.48
A0	B2	C2	D3	3,653,886	1259.02
A0	B1	C2	D3	3,655,397	1259.02
A0	B3	C3	D1	3,665,604	1259.02
A0	B3	C3	D2	3,665,807	1259.02
A0	B2	C1	D3	3,666,455	1259.02
A0	B1	C1	D3	3,667,966	1259.02
A0	B3	C4	D1	3,673,555	1259.02
A0	B3	C4	D2	3,673,758	1259.02
A0	B2	C2	D4	3,690,014	1259.02
A0	B1	C2	D4	3,691,525	1259.02

Table 22 – Aquatic Habitat: All Combinations of Alternatives with Cost and Output					
Plan				*Cost*	*Output*
A0	B2	C1	D4	3,702,583	1259.02
A0	B1	C1	D4	3,704,094	1259.02
A0	B4	C3	D1	3,735,073	1259.02
A0	B4	C3	D2	3,735,276	1259.02
A0	B4	C4	D1	3,743,024	1259.02
A0	B4	C4	D2	3,743,227	1259.02
A2	B2	C2	D3	4,467,564	1305.06
A2	B1	C2	D3	4,469,075	1305.06
A1	B2	C2	D3	4,469,327	1305.06
A1	B1	C2	D3	4,470,838	1305.06
A3	B2	C2	D3	4,472,460	1305.06
A3	B1	C2	D3	4,473,971	1305.06
A2	B3	C3	D1	4,479,282	1305.06
A2	B3	C3	D2	4,479,485	1305.06
A2	B2	C1	D3	4,480,133	1305.06
A1	B3	C3	D1	4,481,045	1305.06
A1	B3	C3	D2	4,481,248	1305.06
A2	B1	C1	D3	4,481,644	1305.06
A1	B2	C1	D3	4,481,896	1305.06
A1	B1	C1	D3	4,483,407	1305.06
A3	B3	C3	D1	4,484,178	1305.06
A3	B3	C3	D2	4,484,381	1305.06
A3	B2	C1	D3	4,485,029	1305.06
A3	B1	C1	D3	4,486,540	1305.06
A2	B3	C4	D1	4,487,233	1305.06
A2	B3	C4	D2	4,487,436	1305.06
A1	B3	C4	D1	4,488,996	1305.06
A1	B3	C4	D2	4,489,199	1305.06
A3	B3	C4	D1	4,492,129	1305.06
A3	B3	C4	D2	4,492,332	1305.06
A2	B2	C2	D4	4,503,692	1305.06
A2	B1	C2	D4	4,505,203	1305.06
A1	B2	C2	D4	4,505,455	1305.06
A1	B1	C2	D4	4,506,966	1305.06
A3	B2	C2	D4	4,508,588	1305.06
A3	B1	C2	D4	4,510,099	1305.06
A2	B2	C1	D4	4,516,261	1305.06
A2	B1	C1	D4	4,517,772	1305.06
A1	B2	C1	D4	4,518,024	1305.06
A1	B1	C1	D4	4,519,535	1305.06
A3	B2	C1	D4	4,521,157	1305.06
A3	B1	C1	D4	4,522,668	1305.06
A2	B4	C3	D1	4,548,751	1305.06
A2	B4	C3	D2	4,548,954	1305.06
A1	B4	C3	D1	4,550,514	1305.06
A1	B4	C3	D2	4,550,717	1305.06
A3	B4	C3	D1	4,553,647	1305.06
A3	B4	C3	D2	4,553,850	1305.06
A2	B4	C4	D1	4,556,702	1305.06
A2	B4	C4	D2	4,556,905	1305.06

Table 22 – Aquatic Habitat: All Combinations of Alternatives with Cost and Output					
Plan				Cost	Output
A1	B4	C4	D1	4,558,465	1305.06
A1	B4	C4	D2	4,558,668	1305.06
A4	B2	C2	D3	4,561,583	1305.06
A3	B4	C4	D1	4,561,598	1305.06
A3	B4	C4	D2	4,561,801	1305.06
A4	B1	C2	D3	4,563,094	1305.06
A4	B3	C3	D1	4,573,301	1305.06
A4	B3	C3	D2	4,573,504	1305.06
A4	B2	C1	D3	4,574,152	1305.06
A4	B1	C1	D3	4,575,663	1305.06
A4	B3	C4	D1	4,581,252	1305.06
A4	B3	C4	D2	4,581,455	1305.06
A4	B2	C2	D4	4,597,711	1305.06
A4	B1	C2	D4	4,599,222	1305.06
A4	B2	C1	D4	4,610,280	1305.06
A4	B1	C1	D4	4,611,791	1305.06
A4	B4	C3	D1	4,642,770	1305.06
A4	B4	C3	D2	4,642,973	1305.06
A4	B4	C4	D1	4,650,721	1305.06
A4	B4	C4	D2	4,650,924	1305.06
A0	B3	C0	D3	3,236,005	1447.44
A0	B3	C0	D4	3,272,133	1447.44
A0	B4	C0	D3	3,305,474	1447.44
A0	B4	C0	D4	3,341,602	1447.44
A2	B3	C0	D3	4,049,683	1493.48
A1	B3	C0	D3	4,051,446	1493.48
A3	B3	C0	D3	4,054,579	1493.48
A2	B3	C0	D4	4,085,811	1493.48
A1	B3	C0	D4	4,087,574	1493.48
A3	B3	C0	D4	4,090,707	1493.48
A2	B4	C0	D3	4,119,152	1493.48
A1	B4	C0	D3	4,120,915	1493.48
A3	B4	C0	D3	4,124,048	1493.48
A4	B3	C0	D3	4,143,702	1493.48
A2	B4	C0	D4	4,155,280	1493.48
A1	B4	C0	D4	4,157,043	1493.48
A3	B4	C0	D4	4,160,176	1493.48
A4	B3	C0	D4	4,179,830	1493.48
A4	B4	C0	D3	4,213,171	1493.48
A4	B4	C0	D4	4,249,299	1493.48
A0	B0	C3	D3	1,668,994	1564.34
A0	B0	C4	D3	1,676,945	1564.34
A0	B0	C3	D4	1,705,122	1564.34
A0	B0	C4	D4	1,713,073	1564.34
A0	B3	C2	D3	3,667,984	1571.02
A0	B3	C1	D3	3,680,553	1571.02
A0	B3	C2	D4	3,704,112	1571.02
A0	B3	C1	D4	3,716,681	1571.02
A0	B4	C2	D3	3,737,453	1571.02
A0	B4	C1	D3	3,750,022	1571.02

Table 22 – Aquatic Habitat: All Combinations of Alternatives with Cost and Output					
Plan				*Cost*	*Output*
A0	B4	C2	D4	3,773,581	1571.02
A0	B4	C1	D4	3,786,150	1571.02
A2	B0	C3	D3	2,482,672	1610.38
A1	B0	C3	D3	2,484,435	1610.38
A3	B0	C3	D3	2,487,568	1610.38
A2	B0	C4	D3	2,490,623	1610.38
A1	B0	C4	D3	2,492,386	1610.38
A3	B0	C4	D3	2,495,519	1610.38
A2	B0	C3	D4	2,518,800	1610.38
A1	B0	C3	D4	2,520,563	1610.38
A3	B0	C3	D4	2,523,696	1610.38
A2	B0	C4	D4	2,526,751	1610.38
A1	B0	C4	D4	2,528,514	1610.38
A3	B0	C4	D4	2,531,647	1610.38
A4	B0	C3	D3	2,576,691	1610.38
A4	B0	C4	D3	2,584,642	1610.38
A4	B0	C3	D4	2,612,819	1610.38
A4	B0	C4	D4	2,620,770	1610.38
A2	B3	C2	D3	4,481,662	1617.06
A1	B3	C2	D3	4,483,425	1617.06
A3	B3	C2	D3	4,486,558	1617.06
A2	B3	C1	D3	4,494,231	1617.06
A1	B3	C1	D3	4,495,994	1617.06
A3	B3	C1	D3	4,499,127	1617.06
A2	B3	C2	D4	4,517,790	1617.06
A1	B3	C2	D4	4,519,553	1617.06
A3	B3	C2	D4	4,522,686	1617.06
A2	B3	C1	D4	4,530,359	1617.06
A1	B3	C1	D4	4,532,122	1617.06
A3	B3	C1	D4	4,535,255	1617.06
A2	B4	C2	D3	4,551,131	1617.06
A1	B4	C2	D3	4,552,894	1617.06
A3	B4	C2	D3	4,556,027	1617.06
A2	B4	C1	D3	4,563,700	1617.06
A1	B4	C1	D3	4,565,463	1617.06
A3	B4	C1	D3	4,568,596	1617.06
A4	B3	C2	D3	4,575,681	1617.06
A2	B4	C2	D4	4,587,259	1617.06
A4	B3	C1	D3	4,588,250	1617.06
A1	B4	C2	D4	4,589,022	1617.06
A3	B4	C2	D4	4,592,155	1617.06
A2	B4	C1	D4	4,599,828	1617.06
A1	B4	C1	D4	4,601,591	1617.06
A3	B4	C1	D4	4,604,724	1617.06
A4	B3	C2	D4	4,611,809	1617.06
A4	B3	C1	D4	4,624,378	1617.06
A4	B4	C2	D3	4,645,150	1617.06
A4	B4	C1	D3	4,657,719	1617.06
A4	B4	C2	D4	4,681,278	1617.06
A4	B4	C1	D4	4,693,847	1617.06

Table 22 – Aquatic Habitat: All Combinations of Alternatives with Cost and Output					
Plan				*Cost*	*Output*
A0	B2	C3	D3	3,680,743	1727.50
A0	B1	C3	D3	3,682,254	1727.50
A0	B2	C4	D3	3,688,694	1727.50
A0	B1	C4	D3	3,690,205	1727.50
A0	B2	C3	D4	3,716,871	1727.50
A0	B1	C3	D4	3,718,382	1727.50
A0	B2	C4	D4	3,724,822	1727.50
A0	B1	C4	D4	3,726,333	1727.50
A2	B2	C3	D3	4,494,421	1773.54
A2	B1	C3	D3	4,495,932	1773.54
A1	B2	C3	D3	4,496,184	1773.54
A1	B1	C3	D3	4,497,695	1773.54
A3	B2	C3	D3	4,499,317	1773.54
A3	B1	C3	D3	4,500,828	1773.54
A2	B2	C4	D3	4,502,372	1773.54
A2	B1	C4	D3	4,503,883	1773.54
A1	B2	C4	D3	4,504,135	1773.54
A1	B1	C4	D3	4,505,646	1773.54
A3	B2	C4	D3	4,507,268	1773.54
A3	B1	C4	D3	4,508,779	1773.54
A2	B2	C3	D4	4,530,549	1773.54
A2	B1	C3	D4	4,532,060	1773.54
A1	B2	C3	D4	4,532,312	1773.54
A1	B1	C3	D4	4,533,823	1773.54
A3	B2	C3	D4	4,535,445	1773.54
A3	B1	C3	D4	4,536,956	1773.54
A2	B2	C4	D4	4,538,500	1773.54
A2	B1	C4	D4	4,540,011	1773.54
A1	B2	C4	D4	4,540,263	1773.54
A1	B1	C4	D4	4,541,774	1773.54
A3	B2	C4	D4	4,543,396	1773.54
A3	B1	C4	D4	4,544,907	1773.54
A4	B2	C3	D3	4,588,440	1773.54
A4	B1	C3	D3	4,589,951	1773.54
A4	B2	C4	D3	4,596,391	1773.54
A4	B1	C4	D3	4,597,902	1773.54
A4	B2	C3	D4	4,624,568	1773.54
A4	B1	C3	D4	4,626,079	1773.54
A4	B2	C4	D4	4,632,519	1773.54
A4	B1	C4	D4	4,634,030	1773.54
A0	B3	C3	D3	3,694,841	2039.50
A0	B3	C4	D3	3,702,792	2039.50
A0	B3	C3	D4	3,730,969	2039.50
A0	B3	C4	D4	3,738,920	2039.50
A0	B4	C3	D3	3,764,310	2039.50
A0	B4	C4	D3	3,772,261	2039.50
A0	B4	C3	D4	3,800,438	2039.50
A0	B4	C4	D4	3,808,389	2039.50
A2	B3	C3	D3	4,508,519	2085.54
A1	B3	C3	D3	4,510,282	2085.54

Table 22 – Aquatic Habitat: All Combinations of Alternatives with Cost and Output					
Plan				*Cost*	*Output*
A3	B3	C3	D3	4,513,415	2085.54
A2	B3	C4	D3	4,516,470	2085.54
A1	B3	C4	D3	4,518,233	2085.54
A3	B3	C4	D3	4,521,366	2085.54
A2	B3	C3	D4	4,544,647	2085.54
A1	B3	C3	D4	4,546,410	2085.54
A3	B3	C3	D4	4,549,543	2085.54
A2	B3	C4	D4	4,552,598	2085.54
A1	B3	C4	D4	4,554,361	2085.54
A3	B3	C4	D4	4,557,494	2085.54
A2	B4	C3	D3	4,577,988	2085.54
A1	B4	C3	D3	4,579,751	2085.54
A3	B4	C3	D3	4,582,884	2085.54
A2	B4	C4	D3	4,585,939	2085.54
A1	B4	C4	D3	4,587,702	2085.54
A3	B4	C4	D3	4,590,835	2085.54
A4	B3	C3	D3	4,602,538	2085.54
A4	B3	C4	D3	4,610,489	2085.54
A2	B4	C3	D4	4,614,116	2085.54
A1	B4	C3	D4	4,615,879	2085.54
A3	B4	C3	D4	4,619,012	2085.54
A2	B4	C4	D4	4,622,067	2085.54
A1	B4	C4	D4	4,623,830	2085.54
A3	B4	C4	D4	4,626,963	2085.54
A4	B3	C3	D4	4,638,666	2085.54
A4	B3	C4	D4	4,646,617	2085.54
A4	B4	C3	D3	4,672,007	2085.54
A4	B4	C4	D3	4,679,958	2085.54
A4	B4	C3	D4	4,708,135	2085.54
A4	B4	C4	D4	4,716,086	2085.54

ATTACHMENT B
All Combinations of Alternative Management Measures (Riparian):

Table 26 –Riparian Habitat: All Combinations of Alternatives with Cost and Output					
Plan				*Cost*	*Output*
A0	B0	C0	D0	0	0.00
A0	B0	C1	D0	444,548	1.16
A0	B0	C2	D0	431,979	1.64
A0	B0	C3	D0	458,836	4.12
A0	B0	C4	D0	466,787	4.12
A0	B0	C0	D1	1,180,921	22.82
A0	B0	C1	D1	1,625,469	23.98
A0	B0	C2	D1	1,612,900	24.46
A0	B0	C0	D2	1,181,124	24.82
A0	B0	C1	D2	1,625,672	25.98
A0	B0	C2	D2	1,613,103	26.46
A0	B0	C3	D1	1,639,757	26.94
A0	B0	C4	D1	1,647,708	26.94
A0	B0	C3	D2	1,639,960	28.94
A0	B0	C4	D2	1,647,911	28.94
A0	B1	C0	D0	2,013,260	30.60
A0	B1	C1	D0	2,457,808	31.76
A0	B1	C2	D0	2,445,239	32.24
A0	B2	C0	D0	2,011,749	34.36
A0	B1	C3	D0	2,472,096	34.72
A0	B1	C4	D0	2,480,047	34.72
A0	B0	C0	D3	1,210,158	35.38
A0	B0	C0	D4	1,246,286	35.38
A0	B2	C1	D0	2,456,297	35.52
A0	B2	C2	D0	2,443,728	36.00
A0	B0	C1	D3	1,654,706	36.54
A0	B0	C1	D4	1,690,834	36.54
A0	B0	C2	D3	1,642,137	37.02
A0	B0	C2	D4	1,678,265	37.02
A0	B2	C3	D0	2,470,585	38.48
A0	B2	C4	D0	2,478,536	38.48
A0	B0	C3	D3	1,668,994	39.50
A0	B0	C4	D3	1,676,945	39.50
A0	B0	C3	D4	1,705,122	39.50
A0	B0	C4	D4	1,713,073	39.50
A0	B3	C0	D0	2,025,847	53.09

Table 26 –Riparian Habitat: All Combinations of Alternatives with Cost and Output					
Plan				*Cost*	*Output*
A0	B4	C0	D0	2,095,316	53.09
A0	B1	C0	D1	3,194,181	53.42
A0	B3	C1	D0	2,470,395	54.25
A0	B4	C1	D0	2,539,864	54.25
A0	B1	C1	D1	3,638,729	54.58
A0	B3	C2	D0	2,457,826	54.73
A0	B4	C2	D0	2,527,295	54.73
A0	B1	C2	D1	3,626,160	55.06
A0	B1	C0	D2	3,194,384	55.42
A0	B1	C1	D2	3,638,932	56.58
A0	B1	C2	D2	3,626,363	57.06
A0	B2	C0	D1	3,192,670	57.18
A0	B3	C3	D0	2,484,683	57.21
A0	B3	C4	D0	2,492,634	57.21
A0	B4	C3	D0	2,554,152	57.21
A0	B4	C4	D0	2,562,103	57.21
A0	B1	C3	D1	3,653,017	57.54
A0	B1	C4	D1	3,660,968	57.54
A0	B2	C1	D1	3,637,218	58.34
A0	B2	C2	D1	3,624,649	58.82
A0	B2	C0	D2	3,192,873	59.18
A0	B1	C3	D2	3,653,220	59.54
A0	B1	C4	D2	3,661,171	59.54
A0	B2	C1	D2	3,637,421	60.34
A0	B2	C2	D2	3,624,852	60.82
A0	B2	C3	D1	3,651,506	61.30
A0	B2	C4	D1	3,659,457	61.30
A0	B2	C3	D2	3,651,709	63.30
A0	B2	C4	D2	3,659,660	63.30
A0	B1	C0	D3	3,223,418	65.98
A0	B1	C0	D4	3,259,546	65.98
A0	B1	C1	D3	3,667,966	67.14
A0	B1	C1	D4	3,704,094	67.14
A0	B1	C2	D3	3,655,397	67.62
A0	B1	C2	D4	3,691,525	67.62
A0	B2	C0	D3	3,221,907	69.74
A0	B2	C0	D4	3,258,035	69.74
A0	B1	C3	D3	3,682,254	70.10

Table 26 –Riparian Habitat: All Combinations of Alternatives with Cost and Output					
Plan				*Cost*	*Output*
A0	B1	C4	D3	3,690,205	70.10
A0	B1	C3	D4	3,718,382	70.10
A0	B1	C4	D4	3,726,333	70.10
A0	B2	C1	D3	3,666,455	70.90
A0	B2	C1	D4	3,702,583	70.90
A0	B2	C2	D3	3,653,886	71.38
A0	B2	C2	D4	3,690,014	71.38
A0	B2	C3	D3	3,680,743	73.86
A0	B2	C4	D3	3,688,694	73.86
A0	B2	C3	D4	3,716,871	73.86
A0	B2	C4	D4	3,724,822	73.86
A0	B3	C0	D1	3,206,768	75.91
A0	B4	C0	D1	3,276,237	75.91
A0	B3	C1	D1	3,651,316	77.07
A0	B4	C1	D1	3,720,785	77.07
A0	B3	C2	D1	3,638,747	77.55
A0	B4	C2	D1	3,708,216	77.55
A0	B3	C0	D2	3,206,971	77.91
A0	B4	C0	D2	3,276,440	77.91
A0	B3	C1	D2	3,651,519	79.07
A0	B4	C1	D2	3,720,988	79.07
A0	B3	C2	D2	3,638,950	79.55
A0	B4	C2	D2	3,708,419	79.55
A0	B3	C3	D1	3,665,604	80.03
A0	B3	C4	D1	3,673,555	80.03
A0	B4	C3	D1	3,735,073	80.03
A0	B4	C4	D1	3,743,024	80.03
A0	B3	C3	D2	3,665,807	82.03
A0	B3	C4	D2	3,673,758	82.03
A0	B4	C3	D2	3,735,276	82.03
A0	B4	C4	D2	3,743,227	82.03
A0	B3	C0	D3	3,236,005	88.47
A0	B3	C0	D4	3,272,133	88.47
A0	B4	C0	D3	3,305,474	88.47
A0	B4	C0	D4	3,341,602	88.47
A0	B3	C1	D3	3,680,553	89.63
A0	B3	C1	D4	3,716,681	89.63
A0	B4	C1	D3	3,750,022	89.63

Table 26 –Riparian Habitat: All Combinations of Alternatives with Cost and Output					
Plan				Cost	Output
A0	B4	C1	D4	3,786,150	89.63
A0	B3	C2	D3	3,667,984	90.11
A0	B3	C2	D4	3,704,112	90.11
A0	B4	C2	D3	3,737,453	90.11
A0	B4	C2	D4	3,773,581	90.11
A0	B3	C3	D3	3,694,841	92.59
A0	B3	C4	D3	3,702,792	92.59
A0	B3	C3	D4	3,730,969	92.59
A0	B3	C4	D4	3,738,920	92.59
A0	B4	C3	D3	3,764,310	92.59
A0	B4	C4	D3	3,772,261	92.59
A0	B4	C3	D4	3,800,438	92.59
A0	B4	C4	D4	3,808,389	92.59
A1	B0	C0	D0	815,441	96.54
A1	B0	C1	D0	1,259,989	97.70
A1	B0	C2	D0	1,247,420	98.18
A1	B0	C3	D0	1,274,277	100.66
A1	B0	C4	D0	1,282,228	100.66
A2	B0	C0	D0	813,678	102.61
A2	B0	C1	D0	1,258,226	103.77
A2	B0	C2	D0	1,245,657	104.25
A2	B0	C3	D0	1,272,514	106.73
A2	B0	C4	D0	1,280,465	106.73
A1	B0	C0	D1	1,996,362	119.36
A1	B0	C1	D1	2,440,910	120.52
A1	B0	C2	D1	2,428,341	121.00
A1	B0	C0	D2	1,996,565	121.36
A1	B0	C1	D2	2,441,113	122.52
A1	B0	C2	D2	2,428,544	123.00
A1	B0	C3	D1	2,455,198	123.48
A1	B0	C4	D1	2,463,149	123.48
A2	B0	C0	D1	1,994,599	125.43
A1	B0	C3	D2	2,455,401	125.48
A1	B0	C4	D2	2,463,352	125.48
A2	B0	C1	D1	2,439,147	126.59
A2	B0	C2	D1	2,426,578	127.07
A1	B1	C0	D0	2,828,701	127.14
A2	B0	C0	D2	1,994,802	127.43

Table 26 –Riparian Habitat: All Combinations of Alternatives with Cost and Output					
Plan				*Cost*	*Output*
A1	B1	C1	D0	3,273,249	128.30
A2	B0	C1	D2	2,439,350	128.59
A1	B1	C2	D0	3,260,680	128.78
A2	B0	C2	D2	2,426,781	129.07
A2	B0	C3	D1	2,453,435	129.55
A2	B0	C4	D1	2,461,386	129.55
A1	B2	C0	D0	2,827,190	130.90
A1	B1	C3	D0	3,287,537	131.26
A1	B1	C4	D0	3,295,488	131.26
A2	B0	C3	D2	2,453,638	131.55
A2	B0	C4	D2	2,461,589	131.55
A1	B0	C0	D3	2,025,599	131.92
A1	B0	C0	D4	2,061,727	131.92
A1	B2	C1	D0	3,271,738	132.06
A1	B2	C2	D0	3,259,169	132.54
A1	B0	C1	D3	2,470,147	133.08
A1	B0	C1	D4	2,506,275	133.08
A2	B1	C0	D0	2,826,938	133.21
A1	B0	C2	D3	2,457,578	133.56
A1	B0	C2	D4	2,493,706	133.56
A2	B1	C1	D0	3,271,486	134.37
A2	B1	C2	D0	3,258,917	134.85
A1	B2	C3	D0	3,286,026	135.02
A1	B2	C4	D0	3,293,977	135.02
A1	B0	C3	D3	2,484,435	136.04
A1	B0	C4	D3	2,492,386	136.04
A1	B0	C3	D4	2,520,563	136.04
A1	B0	C4	D4	2,528,514	136.04
A3	B0	C0	D0	818,574	136.70
A4	B0	C0	D0	907,697	136.70
A2	B2	C0	D0	2,825,427	136.97
A2	B1	C3	D0	3,285,774	137.33
A2	B1	C4	D0	3,293,725	137.33
A3	B0	C1	D0	1,263,122	137.86
A4	B0	C1	D0	1,352,245	137.86
A2	B0	C0	D3	2,023,836	137.99
A2	B0	C0	D4	2,059,964	137.99
A2	B2	C1	D0	3,269,975	138.13

Table 26 –Riparian Habitat: All Combinations of Alternatives with Cost and Output					
Plan				*Cost*	*Output*
A3	B0	C2	D0	1,250,553	138.34
A4	B0	C2	D0	1,339,676	138.34
A2	B2	C2	D0	3,257,406	138.61
A2	B0	C1	D3	2,468,384	139.15
A2	B0	C1	D4	2,504,512	139.15
A2	B0	C2	D3	2,455,815	139.63
A2	B0	C2	D4	2,491,943	139.63
A3	B0	C3	D0	1,277,410	140.82
A3	B0	C4	D0	1,285,361	140.82
A4	B0	C3	D0	1,366,533	140.82
A4	B0	C4	D0	1,374,484	140.82
A2	B2	C3	D0	3,284,263	141.09
A2	B2	C4	D0	3,292,214	141.09
A2	B0	C3	D3	2,482,672	142.11
A2	B0	C4	D3	2,490,623	142.11
A2	B0	C3	D4	2,518,800	142.11
A2	B0	C4	D4	2,526,751	142.11
A1	B3	C0	D0	2,841,288	149.63
A1	B4	C0	D0	2,910,757	149.63
A1	B1	C0	D1	4,009,622	149.96
A1	B3	C1	D0	3,285,836	150.79
A1	B4	C1	D0	3,355,305	150.79
A1	B1	C1	D1	4,454,170	151.12
A1	B3	C2	D0	3,273,267	151.27
A1	B4	C2	D0	3,342,736	151.27
A1	B1	C2	D1	4,441,601	151.60
A1	B1	C0	D2	4,009,825	151.96
A1	B1	C1	D2	4,454,373	153.12
A1	B1	C2	D2	4,441,804	153.60
A1	B2	C0	D1	4,008,111	153.72
A1	B3	C3	D0	3,300,124	153.75
A1	B3	C4	D0	3,308,075	153.75
A1	B4	C3	D0	3,369,593	153.75
A1	B4	C4	D0	3,377,544	153.75
A1	B1	C3	D1	4,468,458	154.08
A1	B1	C4	D1	4,476,409	154.08
A1	B2	C1	D1	4,452,659	154.88
A1	B2	C2	D1	4,440,090	155.36

Table 26 –Riparian Habitat: All Combinations of Alternatives with Cost and Output					
Plan				*Cost*	*Output*
A2	B3	C0	D0	2,839,525	155.70
A2	B4	C0	D0	2,908,994	155.70
A1	B2	C0	D2	4,008,314	155.72
A2	B1	C0	D1	4,007,859	156.03
A1	B1	C3	D2	4,468,661	156.08
A1	B1	C4	D2	4,476,612	156.08
A2	B3	C1	D0	3,284,073	156.86
A2	B4	C1	D0	3,353,542	156.86
A1	B2	C1	D2	4,452,862	156.88
A2	B1	C1	D1	4,452,407	157.19
A2	B3	C2	D0	3,271,504	157.34
A2	B4	C2	D0	3,340,973	157.34
A1	B2	C2	D2	4,440,293	157.36
A2	B1	C2	D1	4,439,838	157.67
A1	B2	C3	D1	4,466,947	157.84
A1	B2	C4	D1	4,474,898	157.84
A2	B1	C0	D2	4,008,062	158.03
A2	B1	C1	D2	4,452,610	159.19
A3	B0	C0	D1	1,999,495	159.52
A4	B0	C0	D1	2,088,618	159.52
A2	B1	C2	D2	4,440,041	159.67
A2	B2	C0	D1	4,006,348	159.79
A2	B3	C3	D0	3,298,361	159.82
A2	B3	C4	D0	3,306,312	159.82
A2	B4	C3	D0	3,367,830	159.82
A2	B4	C4	D0	3,375,781	159.82
A1	B2	C3	D2	4,467,150	159.84
A1	B2	C4	D2	4,475,101	159.84
A2	B1	C3	D1	4,466,695	160.15
A2	B1	C4	D1	4,474,646	160.15
A3	B0	C1	D1	2,444,043	160.68
A4	B0	C1	D1	2,533,166	160.68
A2	B2	C1	D1	4,450,896	160.95
A3	B0	C2	D1	2,431,474	161.16
A4	B0	C2	D1	2,520,597	161.16
A2	B2	C2	D1	4,438,327	161.43
A3	B0	C0	D2	1,999,698	161.52
A4	B0	C0	D2	2,088,821	161.52

Table 26 –Riparian Habitat: All Combinations of Alternatives with Cost and Output					
Plan				*Cost*	*Output*
A2	B2	C0	D2	4,006,551	161.79
A2	B1	C3	D2	4,466,898	162.15
A2	B1	C4	D2	4,474,849	162.15
A1	B1	C0	D3	4,038,859	162.52
A1	B1	C0	D4	4,074,987	162.52
A3	B0	C1	D2	2,444,246	162.68
A4	B0	C1	D2	2,533,369	162.68
A2	B2	C1	D2	4,451,099	162.95
A3	B0	C2	D2	2,431,677	163.16
A4	B0	C2	D2	2,520,800	163.16
A2	B2	C2	D2	4,438,530	163.43
A3	B0	C3	D1	2,458,331	163.64
A3	B0	C4	D1	2,466,282	163.64
A4	B0	C3	D1	2,547,454	163.64
A4	B0	C4	D1	2,555,405	163.64
A1	B1	C1	D3	4,483,407	163.68
A1	B1	C1	D4	4,519,535	163.68
A2	B2	C3	D1	4,465,184	163.91
A2	B2	C4	D1	4,473,135	163.91
A1	B1	C2	D3	4,470,838	164.16
A1	B1	C2	D4	4,506,966	164.16
A3	B0	C3	D2	2,458,534	165.64
A3	B0	C4	D2	2,466,485	165.64
A4	B0	C3	D2	2,547,657	165.64
A4	B0	C4	D2	2,555,608	165.64
A2	B2	C3	D2	4,465,387	165.91
A2	B2	C4	D2	4,473,338	165.91
A1	B2	C0	D3	4,037,348	166.28
A1	B2	C0	D4	4,073,476	166.28
A1	B1	C3	D3	4,497,695	166.64
A1	B1	C4	D3	4,505,646	166.64
A1	B1	C3	D4	4,533,823	166.64
A1	B1	C4	D4	4,541,774	166.64
A3	B1	C0	D0	2,831,834	167.30
A4	B1	C0	D0	2,920,957	167.30
A1	B2	C1	D3	4,481,896	167.44
A1	B2	C1	D4	4,518,024	167.44
A1	B2	C2	D3	4,469,327	167.92

Table 26 –Riparian Habitat: All Combinations of Alternatives with Cost and Output					
Plan				*Cost*	*Output*
A1	B2	C2	D4	4,505,455	167.92
A3	B1	C1	D0	3,276,382	168.46
A4	B1	C1	D0	3,365,505	168.46
A2	B1	C0	D3	4,037,096	168.59
A2	B1	C0	D4	4,073,224	168.59
A3	B1	C2	D0	3,263,813	168.94
A4	B1	C2	D0	3,352,936	168.94
A2	B1	C1	D3	4,481,644	169.75
A2	B1	C1	D4	4,517,772	169.75
A2	B1	C2	D3	4,469,075	170.23
A2	B1	C2	D4	4,505,203	170.23
A1	B2	C3	D3	4,496,184	170.40
A1	B2	C4	D3	4,504,135	170.40
A1	B2	C3	D4	4,532,312	170.40
A1	B2	C4	D4	4,540,263	170.40
A3	B2	C0	D0	2,830,323	171.06
A4	B2	C0	D0	2,919,446	171.06
A3	B1	C3	D0	3,290,670	171.42
A3	B1	C4	D0	3,298,621	171.42
A4	B1	C3	D0	3,379,793	171.42
A4	B1	C4	D0	3,387,744	171.42
A3	B0	C0	D3	2,028,732	172.08
A3	B0	C0	D4	2,064,860	172.08
A4	B0	C0	D3	2,117,855	172.08
A4	B0	C0	D4	2,153,983	172.08
A3	B2	C1	D0	3,274,871	172.22
A4	B2	C1	D0	3,363,994	172.22
A2	B2	C0	D3	4,035,585	172.35
A2	B2	C0	D4	4,071,713	172.35
A1	B3	C0	D1	4,022,209	172.45
A1	B4	C0	D1	4,091,678	172.45
A3	B2	C2	D0	3,262,302	172.70
A4	B2	C2	D0	3,351,425	172.70
A2	B1	C3	D3	4,495,932	172.71
A2	B1	C4	D3	4,503,883	172.71
A2	B1	C3	D4	4,532,060	172.71
A2	B1	C4	D4	4,540,011	172.71
A3	B0	C1	D3	2,473,280	173.24

Table 26 –Riparian Habitat: All Combinations of Alternatives with Cost and Output					
Plan				*Cost*	*Output*
A3	B0	C1	D4	2,509,408	173.24
A4	B0	C1	D3	2,562,403	173.24
A4	B0	C1	D4	2,598,531	173.24
A2	B2	C1	D3	4,480,133	173.51
A2	B2	C1	D4	4,516,261	173.51
A1	B3	C1	D1	4,466,757	173.61
A1	B4	C1	D1	4,536,226	173.61
A3	B0	C2	D3	2,460,711	173.72
A3	B0	C2	D4	2,496,839	173.72
A4	B0	C2	D3	2,549,834	173.72
A4	B0	C2	D4	2,585,962	173.72
A2	B2	C2	D3	4,467,564	173.99
A2	B2	C2	D4	4,503,692	173.99
A1	B3	C2	D1	4,454,188	174.09
A1	B4	C2	D1	4,523,657	174.09
A1	B3	C0	D2	4,022,412	174.45
A1	B4	C0	D2	4,091,881	174.45
A3	B2	C3	D0	3,289,159	175.18
A3	B2	C4	D0	3,297,110	175.18
A4	B2	C3	D0	3,378,282	175.18
A4	B2	C4	D0	3,386,233	175.18
A1	B3	C1	D2	4,466,960	175.61
A1	B4	C1	D2	4,536,429	175.61
A1	B3	C2	D2	4,454,391	176.09
A1	B4	C2	D2	4,523,860	176.09
A3	B0	C3	D3	2,487,568	176.20
A3	B0	C4	D3	2,495,519	176.20
A3	B0	C3	D4	2,523,696	176.20
A3	B0	C4	D4	2,531,647	176.20
A4	B0	C3	D3	2,576,691	176.20
A4	B0	C4	D3	2,584,642	176.20
A4	B0	C3	D4	2,612,819	176.20
A4	B0	C4	D4	2,620,770	176.20
A2	B2	C3	D3	4,494,421	176.47
A2	B2	C4	D3	4,502,372	176.47
A2	B2	C3	D4	4,530,549	176.47
A2	B2	C4	D4	4,538,500	176.47
A1	B3	C3	D1	4,481,045	176.57

Table 26 –Riparian Habitat: All Combinations of Alternatives with Cost and Output					
Plan				*Cost*	*Output*
A1	B3	C4	D1	4,488,996	176.57
A1	B4	C3	D1	4,550,514	176.57
A1	B4	C4	D1	4,558,465	176.57
A2	B3	C0	D1	4,020,446	178.52
A2	B4	C0	D1	4,089,915	178.52
A1	B3	C3	D2	4,481,248	178.57
A1	B3	C4	D2	4,489,199	178.57
A1	B4	C3	D2	4,550,717	178.57
A1	B4	C4	D2	4,558,668	178.57
A2	B3	C1	D1	4,464,994	179.68
A2	B4	C1	D1	4,534,463	179.68
A2	B3	C2	D1	4,452,425	180.16
A2	B4	C2	D1	4,521,894	180.16
A2	B3	C0	D2	4,020,649	180.52
A2	B4	C0	D2	4,090,118	180.52
A2	B3	C1	D2	4,465,197	181.68
A2	B4	C1	D2	4,534,666	181.68
A2	B3	C2	D2	4,452,628	182.16
A2	B4	C2	D2	4,522,097	182.16
A2	B3	C3	D1	4,479,282	182.64
A2	B3	C4	D1	4,487,233	182.64
A2	B4	C3	D1	4,548,751	182.64
A2	B4	C4	D1	4,556,702	182.64
A2	B3	C3	D2	4,479,485	184.64
A2	B3	C4	D2	4,487,436	184.64
A2	B4	C3	D2	4,548,954	184.64
A2	B4	C4	D2	4,556,905	184.64
A1	B3	C0	D3	4,051,446	185.01
A1	B3	C0	D4	4,087,574	185.01
A1	B4	C0	D3	4,120,915	185.01
A1	B4	C0	D4	4,157,043	185.01
A1	B3	C1	D3	4,495,994	186.17
A1	B3	C1	D4	4,532,122	186.17
A1	B4	C1	D3	4,565,463	186.17
A1	B4	C1	D4	4,601,591	186.17
A1	B3	C2	D3	4,483,425	186.65
A1	B3	C2	D4	4,519,553	186.65
A1	B4	C2	D3	4,552,894	186.65

Table 26 –Riparian Habitat: All Combinations of Alternatives with Cost and Output					
Plan				*Cost*	*Output*
A1	B4	C2	D4	4,589,022	186.65
A1	B3	C3	D3	4,510,282	189.13
A1	B3	C4	D3	4,518,233	189.13
A1	B3	C3	D4	4,546,410	189.13
A1	B3	C4	D4	4,554,361	189.13
A1	B4	C3	D3	4,579,751	189.13
A1	B4	C4	D3	4,587,702	189.13
A1	B4	C3	D4	4,615,879	189.13
A1	B4	C4	D4	4,623,830	189.13
A3	B3	C0	D0	2,844,421	189.79
A3	B4	C0	D0	2,913,890	189.79
A4	B3	C0	D0	2,933,544	189.79
A4	B4	C0	D0	3,003,013	189.79
A3	B1	C0	D1	4,012,755	190.12
A4	B1	C0	D1	4,101,878	190.12
A3	B3	C1	D0	3,288,969	190.95
A3	B4	C1	D0	3,358,438	190.95
A4	B3	C1	D0	3,378,092	190.95
A4	B4	C1	D0	3,447,561	190.95
A2	B3	C0	D3	4,049,683	191.08
A2	B3	C0	D4	4,085,811	191.08
A2	B4	C0	D3	4,119,152	191.08
A2	B4	C0	D4	4,155,280	191.08
A3	B1	C1	D1	4,457,303	191.28
A4	B1	C1	D1	4,546,426	191.28
A3	B3	C2	D0	3,276,400	191.43
A3	B4	C2	D0	3,345,869	191.43
A4	B3	C2	D0	3,365,523	191.43
A4	B4	C2	D0	3,434,992	191.43
A3	B1	C2	D1	4,444,734	191.76
A4	B1	C2	D1	4,533,857	191.76
A3	B1	C0	D2	4,012,958	192.12
A4	B1	C0	D2	4,102,081	192.12
A2	B3	C1	D3	4,494,231	192.24
A2	B3	C1	D4	4,530,359	192.24
A2	B4	C1	D3	4,563,700	192.24
A2	B4	C1	D4	4,599,828	192.24
A2	B3	C2	D3	4,481,662	192.72

Table 26 –Riparian Habitat: All Combinations of Alternatives with Cost and Output					
Plan				Cost	Output
A2	B3	C2	D4	4,517,790	192.72
A2	B4	C2	D3	4,551,131	192.72
A2	B4	C2	D4	4,587,259	192.72
A3	B1	C1	D2	4,457,506	193.28
A4	B1	C1	D2	4,546,629	193.28
A3	B1	C2	D2	4,444,937	193.76
A4	B1	C2	D2	4,534,060	193.76
A3	B2	C0	D1	4,011,244	193.88
A4	B2	C0	D1	4,100,367	193.88
A3	B3	C3	D0	3,303,257	193.91
A3	B3	C4	D0	3,311,208	193.91
A3	B4	C3	D0	3,372,726	193.91
A3	B4	C4	D0	3,380,677	193.91
A4	B3	C3	D0	3,392,380	193.91
A4	B3	C4	D0	3,400,331	193.91
A4	B4	C3	D0	3,461,849	193.91
A4	B4	C4	D0	3,469,800	193.91
A3	B1	C3	D1	4,471,591	194.24
A3	B1	C4	D1	4,479,542	194.24
A4	B1	C3	D1	4,560,714	194.24
A4	B1	C4	D1	4,568,665	194.24
A3	B2	C1	D1	4,455,792	195.04
A4	B2	C1	D1	4,544,915	195.04
A2	B3	C3	D3	4,508,519	195.20
A2	B3	C4	D3	4,516,470	195.20
A2	B3	C3	D4	4,544,647	195.20
A2	B3	C4	D4	4,552,598	195.20
A2	B4	C3	D3	4,577,988	195.20
A2	B4	C4	D3	4,585,939	195.20
A2	B4	C3	D4	4,614,116	195.20
A2	B4	C4	D4	4,622,067	195.20
A3	B2	C2	D1	4,443,223	195.52
A4	B2	C2	D1	4,532,346	195.52
A3	B2	C0	D2	4,011,447	195.88
A4	B2	C0	D2	4,100,570	195.88
A3	B1	C3	D2	4,471,794	196.24
A3	B1	C4	D2	4,479,745	196.24
A4	B1	C3	D2	4,560,917	196.24

Table 26 –Riparian Habitat: All Combinations of Alternatives with Cost and Output					
Plan				Cost	Output
A4	B1	C4	D2	4,568,868	196.24
A3	B2	C1	D2	4,455,995	197.04
A4	B2	C1	D2	4,545,118	197.04
A3	B2	C2	D2	4,443,426	197.52
A4	B2	C2	D2	4,532,549	197.52
A3	B2	C3	D1	4,470,080	198.00
A3	B2	C4	D1	4,478,031	198.00
A4	B2	C3	D1	4,559,203	198.00
A4	B2	C4	D1	4,567,154	198.00
A3	B2	C3	D2	4,470,283	200.00
A3	B2	C4	D2	4,478,234	200.00
A4	B2	C3	D2	4,559,406	200.00
A4	B2	C4	D2	4,567,357	200.00
A3	B1	C0	D3	4,041,992	202.68
A3	B1	C0	D4	4,078,120	202.68
A4	B1	C0	D3	4,131,115	202.68
A4	B1	C0	D4	4,167,243	202.68
A3	B1	C1	D3	4,486,540	203.84
A3	B1	C1	D4	4,522,668	203.84
A4	B1	C1	D3	4,575,663	203.84
A4	B1	C1	D4	4,611,791	203.84
A3	B1	C2	D3	4,473,971	204.32
A3	B1	C2	D4	4,510,099	204.32
A4	B1	C2	D3	4,563,094	204.32
A4	B1	C2	D4	4,599,222	204.32
A3	B2	C0	D3	4,040,481	206.44
A3	B2	C0	D4	4,076,609	206.44
A4	B2	C0	D3	4,129,604	206.44
A4	B2	C0	D4	4,165,732	206.44
A3	B1	C3	D3	4,500,828	206.80
A3	B1	C4	D3	4,508,779	206.80
A3	B1	C3	D4	4,536,956	206.80
A3	B1	C4	D4	4,544,907	206.80
A4	B1	C3	D3	4,589,951	206.80
A4	B1	C4	D3	4,597,902	206.80
A4	B1	C3	D4	4,626,079	206.80
A4	B1	C4	D4	4,634,030	206.80
A3	B2	C1	D3	4,485,029	207.60

Table 26 –Riparian Habitat: All Combinations of Alternatives with Cost and Output					
Plan				*Cost*	*Output*
A3	B2	C1	D4	4,521,157	207.60
A4	B2	C1	D3	4,574,152	207.60
A4	B2	C1	D4	4,610,280	207.60
A3	B2	C2	D3	4,472,460	208.08
A3	B2	C2	D4	4,508,588	208.08
A4	B2	C2	D3	4,561,583	208.08
A4	B2	C2	D4	4,597,711	208.08
A3	B2	C3	D3	4,499,317	210.56
A3	B2	C4	D3	4,507,268	210.56
A3	B2	C3	D4	4,535,445	210.56
A3	B2	C4	D4	4,543,396	210.56
A4	B2	C3	D3	4,588,440	210.56
A4	B2	C4	D3	4,596,391	210.56
A4	B2	C3	D4	4,624,568	210.56
A4	B2	C4	D4	4,632,519	210.56
A3	B3	C0	D1	4,025,342	212.61
A3	B4	C0	D1	4,094,811	212.61
A4	B3	C0	D1	4,114,465	212.61
A4	B4	C0	D1	4,183,934	212.61
A3	B3	C1	D1	4,469,890	213.77
A3	B4	C1	D1	4,539,359	213.77
A4	B3	C1	D1	4,559,013	213.77
A4	B4	C1	D1	4,628,482	213.77
A3	B3	C2	D1	4,457,321	214.25
A3	B4	C2	D1	4,526,790	214.25
A4	B3	C2	D1	4,546,444	214.25
A4	B4	C2	D1	4,615,913	214.25
A3	B3	C0	D2	4,025,545	214.61
A3	B4	C0	D2	4,095,014	214.61
A4	B3	C0	D2	4,114,668	214.61
A4	B4	C0	D2	4,184,137	214.61
A3	B3	C1	D2	4,470,093	215.77
A3	B4	C1	D2	4,539,562	215.77
A4	B3	C1	D2	4,559,216	215.77
A4	B4	C1	D2	4,628,685	215.77
A3	B3	C2	D2	4,457,524	216.25
A3	B4	C2	D2	4,526,993	216.25
A4	B3	C2	D2	4,546,647	216.25

Table 26 –Riparian Habitat: All Combinations of Alternatives with Cost and Output					
Plan				*Cost*	*Output*
A4	B4	C2	D2	4,616,116	216.25
A3	B3	C3	D1	4,484,178	216.73
A3	B3	C4	D1	4,492,129	216.73
A3	B4	C3	D1	4,553,647	216.73
A3	B4	C4	D1	4,561,598	216.73
A4	B3	C3	D1	4,573,301	216.73
A4	B3	C4	D1	4,581,252	216.73
A4	B4	C3	D1	4,642,770	216.73
A4	B4	C4	D1	4,650,721	216.73
A3	B3	C3	D2	4,484,381	218.73
A3	B3	C4	D2	4,492,332	218.73
A3	B4	C3	D2	4,553,850	218.73
A3	B4	C4	D2	4,561,801	218.73
A4	B3	C3	D2	4,573,504	218.73
A4	B3	C4	D2	4,581,455	218.73
A4	B4	C3	D2	4,642,973	218.73
A4	B4	C4	D2	4,650,924	218.73
A3	B3	C0	D3	4,054,579	225.17
A3	B3	C0	D4	4,090,707	225.17
A3	B4	C0	D3	4,124,048	225.17
A4	B3	C0	D3	4,143,702	225.17
A3	B4	C0	D4	4,160,176	225.17
A4	B3	C0	D4	4,179,830	225.17
A4	B4	C0	D3	4,213,171	225.17
A4	B4	C0	D4	4,249,299	225.17
A3	B3	C1	D3	4,499,127	226.33
A3	B3	C1	D4	4,535,255	226.33
A3	B4	C1	D3	4,568,596	226.33
A4	B3	C1	D3	4,588,250	226.33
A3	B4	C1	D4	4,604,724	226.33
A4	B3	C1	D4	4,624,378	226.33
A4	B4	C1	D3	4,657,719	226.33
A4	B4	C1	D4	4,693,847	226.33
A3	B3	C2	D3	4,486,558	226.81
A3	B3	C2	D4	4,522,686	226.81
A3	B4	C2	D3	4,556,027	226.81
A4	B3	C2	D3	4,575,681	226.81
A3	B4	C2	D4	4,592,155	226.81

Table 26 –Riparian Habitat: All Combinations of Alternatives with Cost and Output					
Plan				*Cost*	*Output*
A4	B3	C2	D4	4,611,809	226.81
A4	B4	C2	D3	4,645,150	226.81
A4	B4	C2	D4	4,681,278	226.81
A3	B3	C3	D3	4,513,415	229.29
A3	B3	C4	D3	4,521,366	229.29
A3	B3	C3	D4	4,549,543	229.29
A3	B3	C4	D4	4,557,494	229.29
A3	B4	C3	D3	4,582,884	229.29
A3	B4	C4	D3	4,590,835	229.29
A4	B3	C3	D3	4,602,538	229.29
A4	B3	C4	D3	4,610,489	229.29
A3	B4	C3	D4	4,619,012	229.29
A3	B4	C4	D4	4,626,963	229.29
A4	B3	C3	D4	4,638,666	229.29
A4	B3	C4	D4	4,646,617	229.29
A4	B4	C3	D3	4,672,007	229.29
A4	B4	C4	D3	4,679,958	229.29
A4	B4	C3	D4	4,708,135	229.29
A4	B4	C4	D4	4,716,086	229.29

APPENDIX F

REAL ESTATE

OF THE

JACKSON HOLE, WYOMING, ENVIRONMENTAL RESTORATION FEASIBILITY STUDY

Prepared by

Teton Conservation District

APPENDIX F

REAL ESTATE
FOR THE
JACKSON HOLE ENVIRONMENTAL RESTORATION STUDY
AT
JACKSON HOLE, WYOMING

INDEX

APPENDIX F
REAL ESTATE

1. GENERAL.

This appendix provides a real estate perspective on the proposed rehabilitation initiatives and "tools" developed during this co-sponsored environmental restoration study. The purpose is to estimate, for planning, the fee, easement, and other interests necessary for the local sponsors (Teton County, Wyoming Board of Commissioners, and the Teton County Natural Resource District Board of Supervisors), in cooperation with the U.S. Army Corps of Engineers (Walla Walla District), to implement channel stabilization and habitat rehabilitation measures along the Snake River in the Jackson Hole area. Four areas along the Snake River have been selected for environmental restoration to riverine, wetland, and riparian habitats within the active river channel (or between flood control levees) between the southern boundary Grand Teton National Park and the state owned South Park Elk Feed Ground 7 miles south of Jackson, Wyoming.

2. AREA, TOWN, AND NEIGHBORHOOD:

The proposed project area lies within Jackson Hole in the northwestern corner of Wyoming. The "hole" is a broad (approximately 40 miles long and 20 miles wide) high mountain valley resultant from the Teton range uplift and prehistoric glaciation activity with an average base elevation of approximately 6,000 feet. Its borders include the Teton mountain range to the west; the Gros Ventre (Grovont) mountain range to the east; Snake River mountain range to the south, and the Yellowstone Plateau to the north. Teton County is 97 percent public land, with urban and rural development concentrated on the remaining 3 percent of private land located mainly on the southern end of the valley floor and foothills. Public lands include Yellowstone National Park, Grand Teton National Park, the U.S. Fish and Wildlife National Elk Refuge, Bridger-Teton National Forest, Targhee National Forest, Gros Ventre, and Jedadiah Smith Wilderness areas, and land owned by various agencies of the State of Wyoming.

The basis of the Teton County economy is tourism and outdoor recreation which account for approximately 90 percent of economic activity. The major attractions to the area are the two National Parks, home to several endangered species such as the Bald eagle, Grizzly bear and wolves, and the Jackson Hole Mountain summer and ski resort as well as several other popular ski resorts in the area. Jackson Hole is obtaining a wider reputation as a destination resort area featuring world class scenery, wildlife, skiing, fishing, hunting, tennis, and golf. There is also an upward trend, over the last 10 years, in the number of wealthy part-time residents building large second homes in the county that also contributes to the overall growth in the area's vigorous economy.

Jackson is the only incorporated town in the county and provides the typical commercial, service, and public facilities, however there are several unincorporated "villages" and numerous suburban and rural residential neighborhoods. Major employers in the county, varying with the season, include the Jackson Hole Mountain

Ski Resort, Grand Teton Lodge Company, St. John's Hospital, Snow King Resort, Grand Targhee Ski Resort, Grand Teton National Park, and the Teton County School District. The 1990 census indicated a population of 4,472 people in the Town of Jackson and 11,172 in the county for a total population of 15,644 permanent residents. The official estimated 1997 population is 6,052 in town and 14,200 in the county for a total of 20,252. The seasonal resident population is considerably higher than this figure, probably at least double.

Originally, 12 sites were examined for inclusion in this study, but for various reasons, 8 had to be eliminated as viable options. The remaining four have retained their initial numbering for identification purposes, beginning with Site 1 and proceeding upstream to include Sites 4, 9, and 10. The proposed four project sites along the Snake River have similar neighborhood land use and physical characteristics. The prevalent use of adjacent land within the respective neighborhoods is residential use or agricultural use in transition to residential use.

Site 1: Bordered on both sides of the river by land currently in agricultural use. The Lucas U Lazy U ranch to the east and the Resor Family ranch holdings, including a parcel of Bureau of Land Management (BLM) land leased to the Resor family, to the west.

Site 4: Adjacent to large residential tracts, which include numerous luxury homes, ($1 million and up) as well as smaller subdivision sites. The east bank includes mostly land encumbered by conservation easements that restrict development. Larger vacant tracts are owned by several entities including property owned by Harrison Ford.

Site 9: A mix of varied land uses, this site is bounded by a developed river access point used by river recreationists, an industrial gravel processing operation, and smaller vacant and improved residential sites, and subdivision lots to the west, and a large popular public park and BLM land tracts (grazing) to the east of the river.

Site 10: Predominantly small improved and vacant residential sites on the west and large ranchland tracts to the east on Gros Ventre Butte with large luxury homesites to the north of the confluence of the Gros Ventre River with the Snake River.

3. PROPERTY/PROJECT DATA:

a. Site: All four project sites include extensive riparian and riverine habitat, shrub/scrub communities, and cottonwood forest. This includes land abutting the levees, the river banks or islands, and river channels located in the flood plain between the river banks, either in the floodway between existing flood control levees or in a designated flood zone where there are no levees.

By definition each of the individual riparian parcels within the project area fronts on the variable thread of the river. The project areas are accessible for purposes of the restoration project via existing County rights-of-way along the levees. They are also accessible to the public via water craft under the provisions of recreation easements that were granted by each land owner as part of a court judgment settling a

BLM claim to the Snake River riparian land. The soils in all four of the project areas, where they exist, are identified as mostly Tetonville-Riverwash complex with about 40 percent Tetonville fine sandy loam and 40 percent Riverwash, and Teton-Wilsonville fine sandy loams with about 40 percent Tetonville fine sandy loam and about 40 percent Wilsonville fine sandy loam. Riverwash consists of recent alluvial deposits of sand, pebbles, and cobbles. Drainage is generally to the south in a serpentine fashion along the river bed. Topography is nearly flat, sloping slightly, generally to the south.

There are no utilities on any of the project sites except that a power transmission line crosses the river just north of the Wilson-Jackson Bridge in Area 9; electric power and telephone service are within distances ranging from 1/8 to 1/2 mile from the other areas. There is no timber having commercial value. There are no known mineral deposits having any commercial value. All of the four project areas contain deposits of gravel and river run rock suitable for gravel extraction and processing, which is subject to county and state control. Securing a permit for new commercial gravel extraction in the valley is difficult due to the heavy truck traffic, noise, and dust generated by extraction and processing. Extraction of 1,000 cubic yards or less for site specific development and wildlife habitat enhancement is exempt from county regulations.

The proposed channel stabilization and habitat restoration work consists of channel excavation and re-alignment; placement of spur dikes; training fences; brush fences; anchored root wads; boulders or other structures; or devices designed to modify, influence, or direct the velocity or flow of the river.

b. Improvements: There are no planned improvements, from a real estate perspective, on any of the project lands.

c. Zoning: The Snake River flood plain lands do not have a county zoning classification per se since development, except for essential facilities for flood control, irrigation, or essential utility crossings, is prohibited within the 10 year flood plain by county land use regulations. These flood plains, which include the four project areas, are all located in a designated Natural Resources Overlay (NRO) district. The purpose of the NRO district is to provide protection to the most important and sensitive natural areas throughout the county that provide critical winter habitat and migration routes that are essential for the survival of the elk, mule deer, and moose, nesting habitat that is essential to the survival of the bald eagle and trumpeter swan, and spawning areas that are essential to the survival of the fine-spotted cutthroat trout. In other areas, where development is allowed, an environmental analysis may be required to determine how to minimize and mitigate the impact of the development on the wildlife resources.

Ownership Data: Property ownership and estimated individual tract requirements within each of the project areas are shown in paragraph 4 and summarized below. In some instances there are multiple parcels located within the proposed sites that are under single ownership. In those cases, each parcel will be treated individually with site specific easement language.

Site 1: Encompasses an area of approximately 360 acres. Given the current location of the thread of the active river along the west edge of the floodplain, four ownership's are recognized as being affected by the proposed project. Two private located within the site, one public (BLM), and one private ownership that will be affected by access to the site.

Site 4: Includes approximately 157 ± acres within nine riparian ownership's ranging from 4 to 32 acres. Six of the parcels are from 13 to 32 acres, the other four are smaller.

Site 9: Includes approximately 89 acres within 11 riparian ownership's ranging from 0.5 to 70 acres. Seven of the parcels are from 0.5 to 1.5 acres. One BLM tract is 70 acres.

Site 10: Includes about 335 acres within 13 ownership's ranging from 1 to 65 acres per tract with 8 parcels 10 to 65 acres and 7 ranging from 1 to 9 acres each.

e. Existing project: Existing easements include the previously acquired county levee easements and the public recreation easements that were granted as part of the settlement of a prior BLM claim to the title of riparian lands along the river. The county easements were historically obtained without cost as the levees were built in consideration for the flood control benefits to the landowners. The landowners were not paid for the recreation easements that they were required to grant under the terms of the court judgement giving clear title to the disputed lands.

f. Environmental issues: There are no known environmental hazards such as the presence of toxic material on the project lands. The only known environmental issue involved is the maintenance of existing wildlife habitat, which the project is intended to improve.

g. Landowner attitudes: Given the potential benefits of the restoration "tools" a majority of the landowners located within the proposed project areas willingly support the proposed restoration efforts. However, it is possible that some land owners may not be willing to grant even a beneficial easement that allows even temporary construction equipment access or activity on their land. In these cases, the sponsor has the option of changing the project area locations.

4. REAL ESTATE REQUIREMENTS:

Real estate requirements are based upon site maps[1] with restoration features located, given the existing geomorphology of the year the aerial photos were taken and do not necessarily represent the actual projects.

Existing Easements. To the maximum extent possible, the Government and the non-Federal sponsor will use existing easements to implement the restoration project. Analysis as to the sufficiency and availability of rights under existing easements is ongoing via individual deed review. For parcels upon which restoration features are

[1] See Addendum

proposed and an easement does not exist or is considered insufficient, the non-Federal sponsor will procure an appropriate easement for ecosystem restoration on a willing-seller basis. The easement will be for the purpose of restoring the Snake River's natural environment and will be crafted to acquire only the rights needed for the restoration features to be located on that particular parcel. For parcels on which existing access rights do not exist or are insufficient, the non-Federal sponsor will acquire a road easement estate if required for permanent access. For temporary access, rights would be acquired under a temporary work area easement or temporary road easement.

Acquisition Schedule: Once restoration areas are prioritized, procurement of additional easements should begin not less than 6 months prior to the desired starting construction date. The relatively short timeframe is driven due to the yearly adjustment in the geomorphology of the river creating a need for last minute adjustments to the engineering plan, and the late fall construction window limited by wildlife concerns and river flow regime.

Special Requirements: The BLM is the land manager on three parcels within the proposed restoration areas. The BLM does not currently have a land management plan in place for lands under their jurisdiction located in Teton County; therefore, an application for a free use permit will be required if bedload material is to be excavated. The free use permit application will be submitted by the local sponsor to the area BLM Office in Rock Springs, Wyoming. Once the application is received a 30-day public notice will be issued by the BLM at the end of which the permit is awarded.

Teton County is the land manager in one of the proposed restoration areas and has regulatory authority over gravel extractions. Upon initiation of the project a comprehensive extraction permit would be sought from the county, which would cover all of the proposed extractions within the proposed project scope. Plans providing the excavation details would be delivered to the Teton County Planning Office and held for review by the planning staff.

The Wyoming Department of Transportation has a maintenance easement at the Wilson-Jackson Bridge, which lies within one of the proposed restoration areas. While no permits are required, any excavation plan that involves this area should be sent to the Resident Engineer for their review.

Real Estate Requirements by Area: The following section will discuss by area and parcel which proposed restoration tools will be used.

Area 1:

Landowner	Restoration Features
Joyce Lucas/Bob Lucas	Channel Capacity Excavation, Side Pool Excavation, Brush Fences Anchored Logs or Trees and Supply Channels for Side Pools
Sewell Partners	Brush Fences and Anchored Logs or Trees
Bureau of Land Management	Sediment Trap
Porter Estates	Access to Area

Area 4:
NOTE: Access to both sides of the project will be from the levee systems on both sides of the river. Appropriate notice will be given to landowners along the levees prior to any construction.

Landowner	Restoration Features
Tozzi	Brush Fences and Sediment Trap
Cheramy	Brush Fences and Sediment Trap
Malinski "A"	Sediment Trap and Supply Channel
Malinsky "C"	Brush Fences, Sediment Trap, Supply Channel, Side Pool and Anchored Logs or Trees
Canyon Oaks	Brush Fences, Sediment Trap, Supply Channel, Side Pool, Anchored Logs or Trees and Channel Capacity Excavation
Lammers	Brush Fences, Supply Channel, Anchored Logs or Trees and Channel Capacity Excavation
Circle L Partners	Brush Fences, Supply Channel, Anchored Logs or Trees and Channel Capacity Excavation
Ford-North	Sediment Trap
Neilson Ranch-North	Spur Dike, Sediment Trap and Pool
Ford-South	Sediment Trap, Pool, Supply Channel, Anchored Logs or Trees and Brush Fences
Neilson Ranch-South	Brush Fences, Supply Channel, Anchored Logs or Trees, Channel Capacity Excavation and Pool
Roliz	Brush Fences, Supply Channel, Anchored Logs or Trees, Channel Capacity Excavation and Pool

Area 9:
Access will be via existing levees.

Landowner	Restoration Features
Bureau of Land Management	Brush Fences, Anchored Logs or Trees, Rock Grade Control, Channel Capacity Excavation, Pool Supply Channels and Anchored Logs or Trees
River Springs Partners	Channel Capacity Excavation and Spur Dikes
Wyoming Department of Transportation	Channel Capacity Excavation
Kindred	Channel Capacity Excavation
Zachritz	Channel Capacity Excavation
Jacobson	Channel Capacity Excavation
Thieme	Channel Capacity Excavation
Rino	Channel Capacity Excavation
T.S.R. Limited	Channel Capacity Excavation and Anchored Logs or Trees
Bresden	Pool, Anchored Logs or Trees and Channel Capacity Excavation
Teton County	Channel Capacity Excavation

Area 10:
Access would be covered under existing routes unless reconfiguration of the channel network requires access from the northwest corner of the project area.

Landowner	Restoration Features
Core Partners	Sediment Trap and Spur Dike
Hoke	Anchored Logs or Trees
John Dodge Homeowners (#51)	Brush Fences and Anchored Logs or Trees
Cohen	Pool
Mead	Spur Dikes and Sediment Trap
Cook	Sediment Trap, Pool, Brush Fences and Anchored Logs or Trees
Bureau of Land Management	Pool, Anchored Logs or Trees and Brush Fences
W.G.V.B.	Sediment Trap, Anchored Logs or Trees and Channel Capacity Excavation
Berney	Anchored Logs or Trees
Bear Island Partners	Anchored Logs or Trees
Ackerman	Spur Dike, Brush Fences, Anchored Logs or Trees and Sediment Trap
Bird	Brush Fences and Sediment Trap
Wolfensohn	Sediment Trap

The BLM will require free use permits on three parcels. Teton County will require a blanket permit for all excavations.

5. SUMMARY OF REAL ESTATE COSTS:

The sponsor will use easements for ecosystem restoration and access, where a levee easement does not already exist or is insufficient, to obtain access and the right to install restoration features. (The sponsor will not use condemnation to obtain any easement or access). The restoration features proposed will likely benefit the properties involved. Therefore, compensation normally awarded to offset any adverse effect of a proposed activity usually requiring an easement (*i.e.,* utilities) is insignificant in this case. For planning purposes it is estimated that easement acquisition will occur at a nominal cost of $1,000 per easement for not more than 33 parcels.

The following is for planning purposes only and no prioritization is to be implied. It is anticipated that a separate project cost agreement (PCA) will be required for each project area.

AREA 10:

ITEM	QUANTITY	UNIT	COST	PROJECT
Land				
Easements	12	$1,000	$12,000	
Permits (BLM)	1	0	0	
		Sub-total	$12,000	
		Contingency (20 percent)[2]	$2,400	
		Total Land		*$14,400*
ADMINISTRATION				
(SPONSOR)				
Mapping & Survey	12	$2,500	$30,000	
Title Evidence	12	$75	$900	
Appraisal	12	$1000	$12,000	
Negotiation & Closing	12	$1,150	$13,800	
P.L. 91-646 (Title III)	12	$200	$2,400	
		Sub-total	$59,100	
		Contingency (20 percent)	$11,820	
	Total Sponsor	*Administration costs*		*$70,920*
ADMINISTRATION				
(GOVERNMENT)				
Federal Review & Assistance	1		$13,000	
		Sub-total	$13,000	
		Contingency (20 percent)	$2,600	
	Total Government	*Administration costs*		*$15,600*

TOTAL REAL ESTATE COSTS-AREA 10 .... $100,920

[2] A 20 percent contingency has been added to each category comprising this project grand total. This allows for negotiation latitude and the passage of time between this report and actual real estate acquisition.

AREA 9:

ITEM	QUANTITY	UNIT	COST	PROJECT
Land				
Easements)	8	$1,000	$8,000	
Permits (BLM)	1	0	0	
		Sub-total	$8,000	
		Contingency (20 percent)	$1,600	
		Total Land		*$9,600*
ADMINISTRATION				
(SPONSOR)				
Mapping & Survey	8	$2,500	$20,000	
Title Evidence	8	$75	$600	
Appraisal	8	$1000	$8,000	
Negotiation & Closing	8	$1,150	$9,200	
P.L. 91-646 (Title III)	8	$200	$1,600	
		Sub-total	$39,400	
		Contingency (20 percent)	$7,880	
	Total Sponsor	*Administration costs*		*$47,280*
ADMINISTRATION				
(GOVERNMENT)				
Federal Review & Assistance	1		$9,000	
		Sub-total	$9,000	
		Contingency (20 percent)	$1,800	
	Total Government	*Administration costs*		*$10,800*
TOTAL REAL ESTATE COSTS-AREA 9				$67,680

AREA 4:

ITEM	QUANTITY	UNIT	COST	PROJECT
Land				
Easements)	12	$1,000	$12,000	
Permits (BLM)	0	0	0	
		Sub-total	$12,000	
		Contingency (20 percent)	$2,400	
		Total Land		*$14,400*
ADMINISTRATION				
(SPONSOR)				
Mapping & Survey	12	$2,500	$30,000	
Title Evidence	12	$75	$900	
Appraisal	12	$1000	$12,000	
Negotiation & Closing	12	$1,150	$13,800	
P.L. 91-646 (Title III)	12	$200	$2,400	
		Sub-total	$59,100	
		Contingency (20 percent)	$11,820	
	Total Sponsor	*Administration costs*		*$70,920*
ADMINISTRATION				
(GOVERNMENT)				
Federal Review & Assistance	1		$12,000	
		Sub-total	$12,000	
		Contingency (20 percent)	$2,400	
	Total Government	*Administration costs*		*$14,400*

TOTAL REAL ESTATE COSTS-AREA 4 .... $99,720

AREA 1:

ITEM	QUANTITY	UNIT	COST	PROJECT
Land				
Easements)	2	$1,000	$2,000	
Permits (BLM)	1	0	0	
		Sub-total	$2,000	
		Contingency (20 percent)	$400	
		Total Land		*$2,400*
ADMINISTRATION				
(SPONSOR)				
Mapping & Survey	2	$2,500	$5,000	
Title Evidence	2	$75	$150	
Appraisal	2	$1000	$2000	
Negotiation & Closing	2	$1,150	$2,300	
P.L. 91-646 (Title III)	2	$200	$400	
		Sub-total	$9,850	
		Contingency (20 percent)	$1,970	
	Total Sponsor	*Administration costs*		*$11,820*
ADMINISTRATION				
(GOVERNMENT)				
Federal Review & Assistance	1		$3,000	
		Sub-total	$3,000	
		Contingency (20 percent)	$600	
	Total Government	*Administration costs*		*$3,600*

TOTAL REAL ESTATE COSTS-AREA 1 .... $17,820

TOTAL REAL ESTATE COSTS-AREA'S 10-9-4-1 .... $286,140[3]

[3] Stated in 1999 Dollars

6. RECOMMENDATIONS:

It is recommended that the real estate plan described within this appendix be approved as written subject to the availability of funds. It incorporates, as key elements, the use of existing easements to the greatest extent practicable, the acquisition of easements for ecosystem restoration or access where necessary.

ADDENDUM #1

Real Estate Milestones After Feasibility

This addendum provides details on the tasks associated with the real estate aspects of the proposed restoration project.

REAL ESTATE MILESTONES AFTER FEASIBILITY

ACTIVITY	COE INITIATE	COE COMPLETE	LS INITIATE	LS COMPLETE
Formal Transmittal of Final ROW drawings to LS & Instruction to Acquire LEERD		PCA + .25 Months		
Prepare Mapping & Legal Descriptions			PCA + .25 Months	PCA + 1.5 Months
Obtain Title Evidence			PCA + 1.5 Months	PCA + 2.0 Months
Obtain Tract Appraisals			PCA + 1.5 Months	PCA + 2.5 Months
Review Tract Appraisals	PCA + 2.75 Months	PCA + 3.25 Months		
Conduct Negotiations			PCA + 3.25 Months	PCA + 6.0 Months
Obtain Possession				PCA + 6.0 Months

ADDENDUM #2

Jackson Hole Ecosystem Restoration Easement

This Addendum Provides an example of non-standard easement that would be used by the sponsor for acquisition of rights to perform restoration work on a landowner's property.

Jackson Hole Ecosystem Restoration Easement

KNOW ALL MEN BY THESE PRESENTS, that in consideration of Ten Dollars and other valuable consideration, the undersigned owner of land, hereinafter called the "GRANTOR," does hereby grant to **TETON COUNTY, WYOMING**, hereinafter called the "GRANTEE," its successors, and assigns, a perpetual and assignable easement in, on, over and across the land described on the Exhibit "A" attached hereto, for the purpose of restoring the Snake River's natural environment. This easement includes the right to build, construct, operate, maintain, reconstruct, repair, rehabilitate, and replace certain works and features including (spur dikes), (anchoring logs or trees), (brush fences), (side channels), (rock grade control structures), (pools), (together with the right to extract, use, remove, and dispose of rocks, sand, and gravel).

ADDENDUM #3

Assessment of Non-Federal Sponsor's Real Estate Acquisition Capability

ASSESSMENT OF NON-FEDERAL SPONSOR'S REAL ESTATE ACQUISITION CAPABILITY

SPONSOR PORTION A

I. LEGAL AUTHORITY		
YES	NO	
X		a. Does the sponsor have legal authority to acquire and hold title to real property for project purposes? Cite Statutory Authority: W.S.§18-2-101
X		b. Does the sponsor have the power of eminent domain for this project? Cite Statutory Authority: W.S.§1-26-801
	X	c. Does the sponsor have "quick-take" authority for this project? Cite Statutory Authority:
	X	d. Are there any lands/interests in land required for the project located outside the sponsor's political boundary?
X		e. Are any of the lands/interests in land required for the project owned by an entity whose property the sponsor cannot condemn? (If "yes", provide description on attached sheets.)

PREPARED BY:

PAUL VAUGHN

Attorney for Sponsor

Date: 5/28/98

Reviewed and Approved:

Richard Carlton

Richard Carlton
Chief, Real Estate Division

Date: 5/4/99

ASSESSMENT OF NON-FEDERAL SPONSOR'S REAL ESTATE ACQUISITION CAPABILITY

SPONSOR PORTION B

II. HUMAN RESOURCE REQUIREMENTS		
YES	NO	
	X	a. Will the sponsor's in-house staff require training to become familiar with real estate requirements of Federal projects including P.L. 91-646, as amended?
	X	b. If the answer to II.a. is "yes", has a reasonable plan been developed to provide such training? (If "yes", provide description on attached sheets.)
X		c. Does the sponsor's in-house staff have sufficient real estate acquisition experience to meet its responsibilities for the project?
X		d. Is the sponsor's projected in-house staffing level sufficient considering its other work load?
X		e. Can the sponsor obtain contractor support, if required, in a timely fashion?
	X	f. Will the sponsor likely request USACE assistance in acquiring real estate? (If "yes", provide description on attached sheets.)
III. OTHER PROJECT VARIABLES		
YES	NO	
X		a. Will the sponsor's staff be located within reasonable proximity to the project site?
X		b. Has the sponsor approved the project/real estate schedule/milestones?

PREPARED BY:

Robert S. Shaw

Sponsor Representative

Date: ______________

Reviewed and Approved:

Richard Carlton

Richard Carlton
Chief, Real Estate Division

Date: 5/4/99

ASSESSMENT OF NON-FEDERAL SPONSOR'S REAL ESTATE ACQUISITION CAPABILITY

U. S. GOVERNMENT PORTION

<table>
<tr><th colspan="4">IV. OVERALL ASSESSMENT</th></tr>
<tr><td>YES</td><td>NO</td><td>NA</td><td></td></tr>
<tr><td>X</td><td></td><td></td><td>a. Has the sponsor performed satisfactorily on other USACE projects?</td></tr>
<tr><td colspan="3"></td><td>b. With regard to this project, the sponsor is anticipated to be (check one)</td></tr>
<tr><td colspan="3"></td><td>highly capable</td></tr>
<tr><td colspan="3"></td><td>fully capable</td></tr>
<tr><td colspan="3">X</td><td>moderately capable</td></tr>
<tr><td colspan="3"></td><td>marginally capable</td></tr>
<tr><td colspan="3"></td><td>insufficiently capable — If sponsor is believed to be "insufficiently capable", provide explanation on attached sheet</td></tr>
</table>

<table>
<tr><th colspan="3">V. COORDINATION</th></tr>
<tr><td>YES</td><td>NO</td><td></td></tr>
<tr><td></td><td>X</td><td>a. Has this assessment been coordinated with the sponsor?</td></tr>
<tr><td></td><td></td><td>b. Does the sponsor concur with this assessment? (If no provide explanation on attached sheet.)</td></tr>
</table>

Richard Carlton

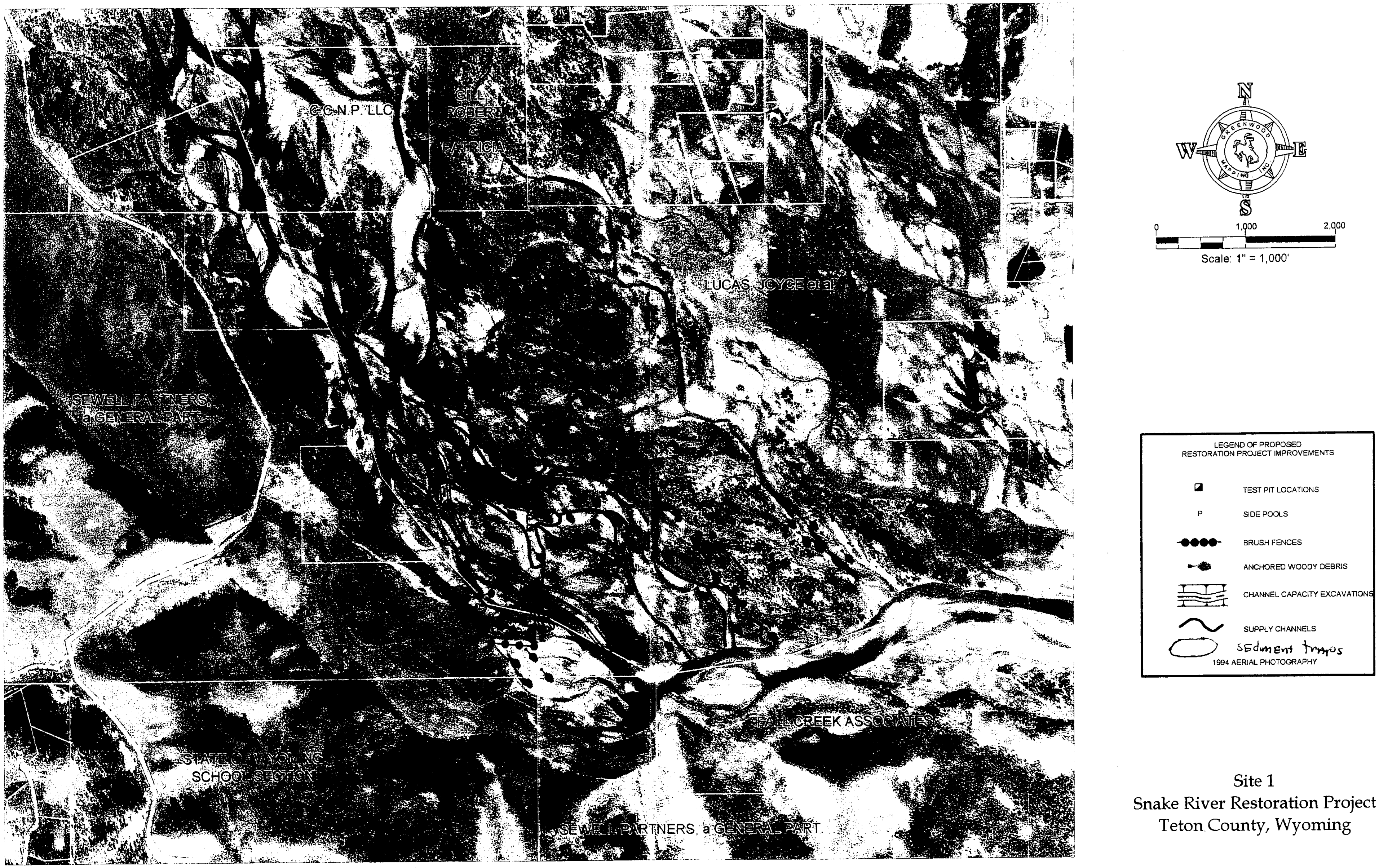
RICHARD CARLTON
Chief, Real Estate Division

Date: 5/4/99

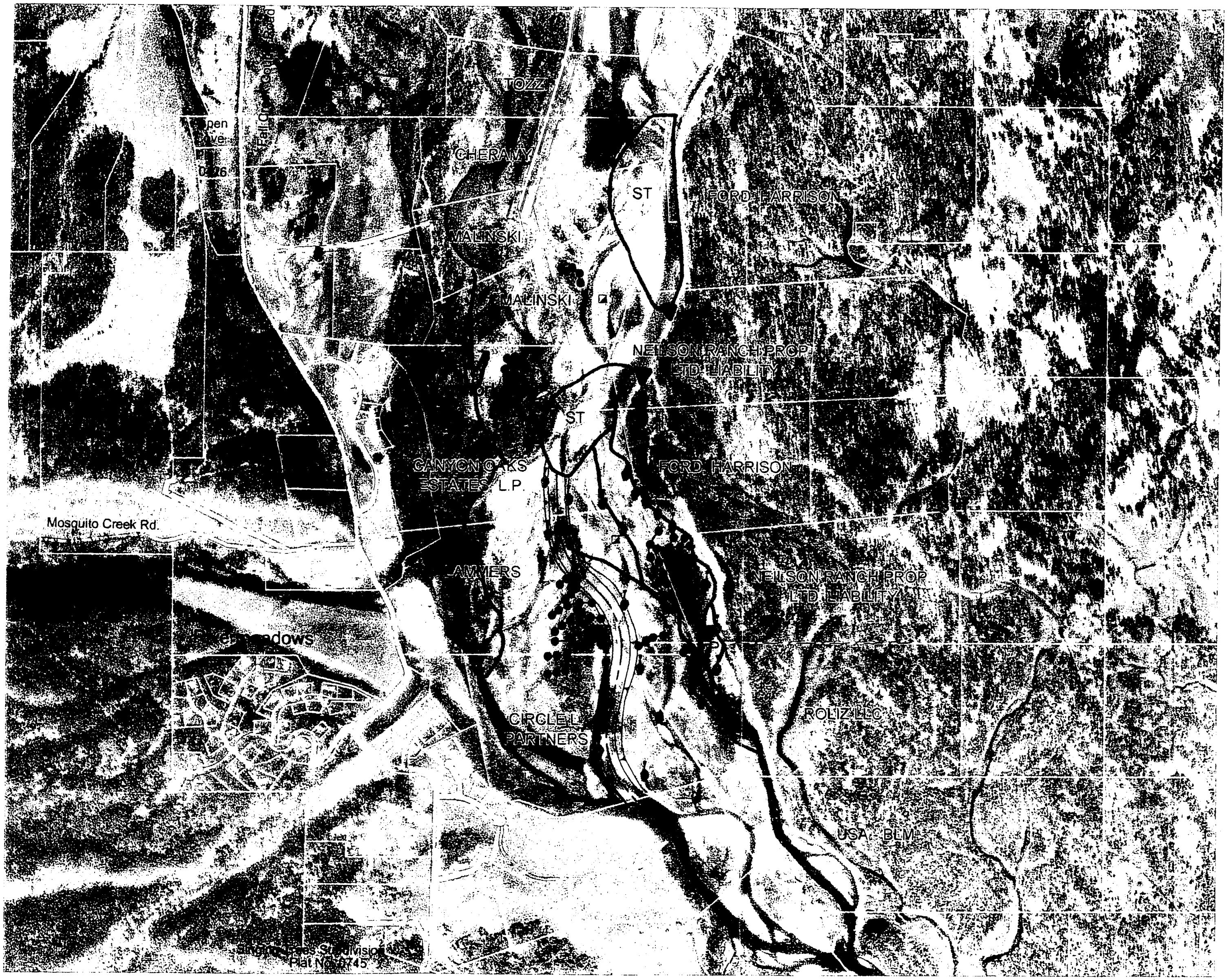
ADDENDUM 4

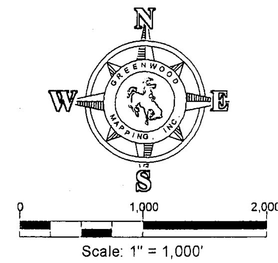
Project Area Maps

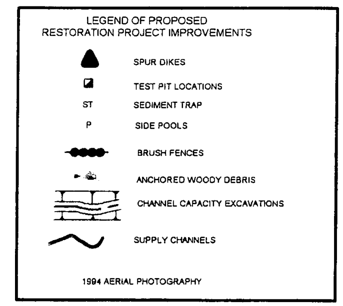
The maps were produced using 1996 aerial photography and the placement of the restoration features are representative of the proposed project if it had been attempted that year. For purposes of this addendum, the maps provide an example, for planning purposes, of the possible location of the restoration features and therefore the easements required prior to commencement of restoration efforts within a given area. It is to be understood that the actual location of the restoration features in any given year will vary and in reality are dependant on several factors including but not limited to the existing geomorphology of the river system in the year restoration will be attempted.



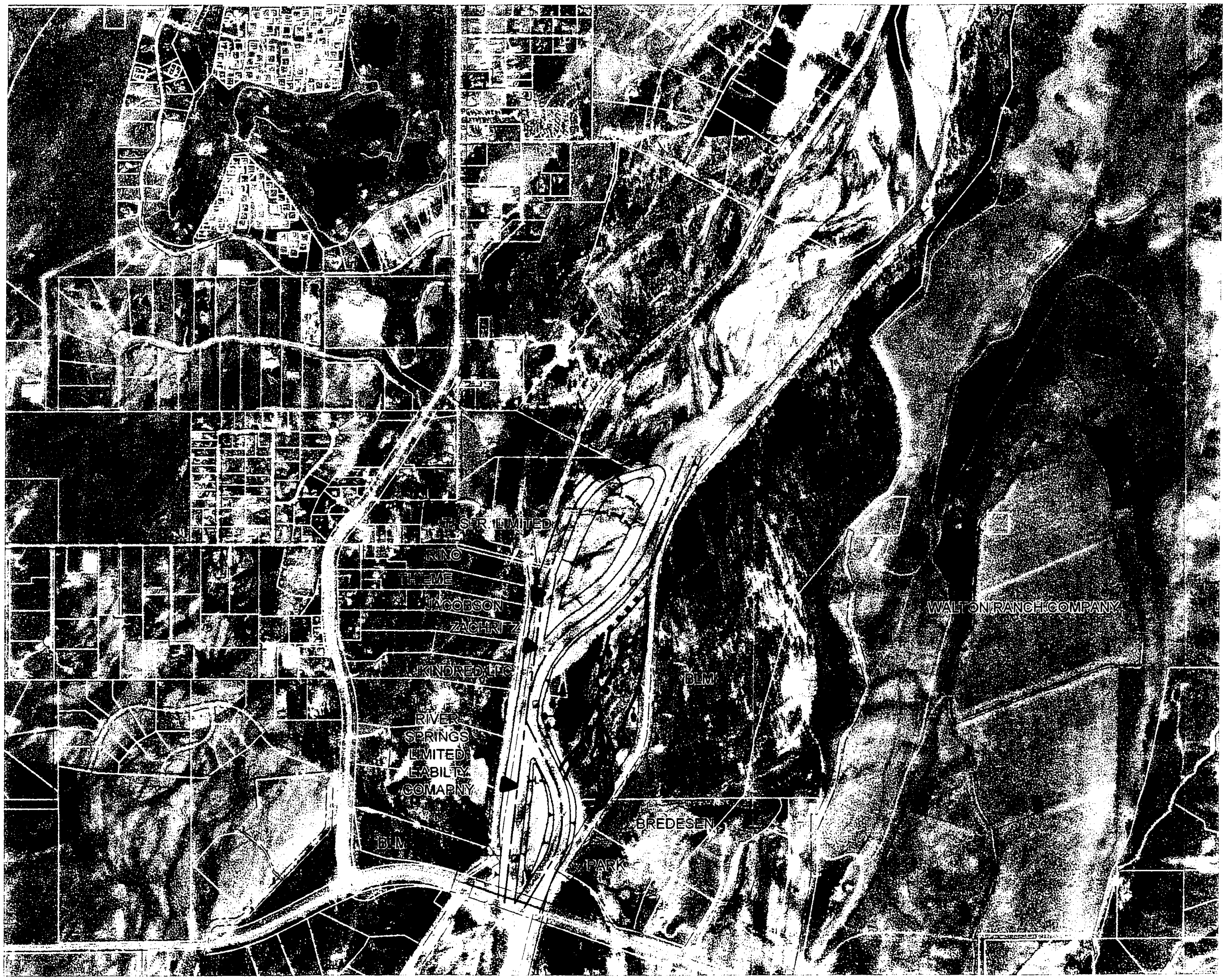
Site 1
Snake River Restoration Project
Teton County, Wyoming







Site 4
Snake River Restoration Project
Teton County, Wyoming



N
W E
S
GREENWOOD MAPPING, INC.

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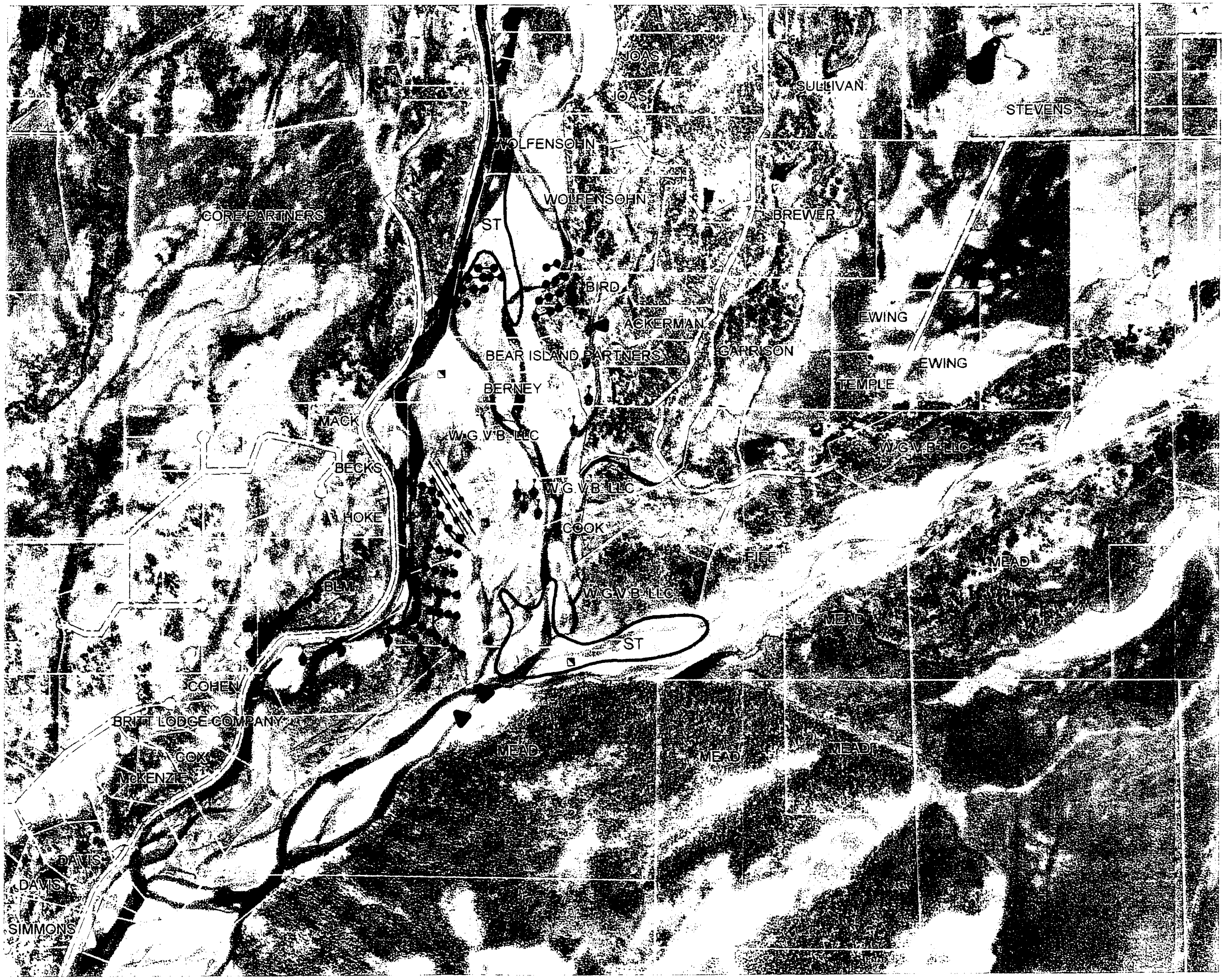
Scale: 1" = 1,000'

LEGEND OF PROPOSED
RESTORATION PROJECT IMPROVEMENTS

SPUR DIKES (REPRESENTS 5 SPUR DIKES)
TEST PIT LOCATION
P SIDE POOLS
LOG PLACEMENT
BRUSH FENCES
ANCHORED WOODY DEBRIS
ROCK GRADE CONTROL
CHANNEL CAPACITY EXCAVATIONS
SUPPLY CHANNELS

1994 AERIAL PHOTOGRAPHY

Site 9
Snake River Restoration Project
Teton County, Wyoming



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0 1,000 2,000

Scale: 1" = 1,000'

LEGEND OF PROPOSED
RESTORATION PROJECT IMPROVEMENTS

SPUR DIKES
TEST PIT LOCATION
ST SEDIMENT TRAPS
P SIDE POOLS
BRUSH FENCES
ANCHORED WOODY DEBRIS
CHANNEL CAPACITY EXCAVATIONS

1994 AERIAL PHOTOGRAPHY

Site 10
Snake River Restoration Projec
Teton County, Wyoming

APPENDIX G

COST ESTIMATES

OF THE

JACKSON HOLE, WYOMING, ENVIRONMENTAL RESTORATION FEASIBILITY STUDY

THIS ESTIMATE IS BASED ON THE SCOPE CONTAINED IN THE Pre-Draft Feasibility Report, DATED: June 1999

PROJECT: PROGRESSIVE NER PLAN - Jackson Hole, Wyoming, Environmental Restoration Project
DISTRICT: Walla Walla
LOCATION: Jackson Hole, Wyoming
P.O.C.: KIM CALLAN, CHIEF, COST ENGINEERING

ACCOUNT NUMBER	FEATURE DESCRIPTION	CURRENT MCACES ESTIMATE PREPARED: February 2000, EFFECTIVE PRICING LEVEL: 1 October 1999 COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	AUTHORIZ./BUDGET YEAR: 2001, EFFECT. PRICING LEVEL: 1 OCT 00 COST ($K)	CNTG ($K)	TOTAL ($K)	.........FULLY FUNDED ESTIMATE......... ($K)	COST ($K)	CNTG ($K)	FULL ($K)
06.3--	WILDLIFE FACILITIES & SANCTUARIES	35,235	7,047	20%	42,282	37,603	7,517	45,120		44,970	8,991	53,961
	TOTAL CONSTRUCTION COSTS ===>	35,235	7,047	20%	42,282	37,603	7,517	45,120		44,970	8,991	53,961
01---	LANDS AND DAMAGES	901	180	20%	1,081	961	192	1,153		1,176	234	1,410
30---	PLANNING, ENGINEERING & DESIGN	3,171	634	20%	3,805	3,385	676	4,061		3,878	775	4,653
31---	CONSTRUCTION MANAGEMENT	2,819	564	20%	3,383	3,008	603	3,611		3,598	719	4,317
06---	MONITORING	1,409	282	20%	1,691	1,504	302	1,806		1,799	360	2,158
	TOTAL PROJECT COSTS ========>	43,535	8,707	20%	52,242	46,461	9,290	55,751		55,420	11,079	66,499

Federal Cost: 65% 43,225
Non-Federal Cost: 35% 23,274

THIS TPCS REFLECTS A PROJECT COST CHANGE OF $
DISTRICT APPROVED: ~~~ ~~~~~ ~~~~~~~~
DISTRICT APPROVED DATE: ____/____/______

TOTAL FEDERAL COSTS ==============> 43,225
TOTAL NON-FEDERAL COSTS ==========> 23,274
THE MAXIMUM PROJECT COST IS =======> $ 66,499

[signature] CHIEF, COST ENGINEERING, Kim Callan
Richard Carlton CHIEF, REAL ESTATE, Richard Carlton
[signature] CHIEF, PLANNING, Dennis Cannon
[signature] CHIEF, ENGINEERING, Surya Bhamidipaty
Wayne H John CHIEF, OPERATIONS, Wayne John
[signature] CHIEF, CONSTRUCTION, John Treadwell
Julie McKee for CHIEF, CONTRACTING, Jackie Anderson
W MacDonald PROJECT MANAGER, William MacDonald
George R Veighey CHIEF, PM-PB, George Veighey
George R Veighey for CHIEF, PPPMD, James Waddell

NOTE: Valid only when completely signed.

Walla Walla District

THIS ESTIMATE IS BASED ON THE SCOPE CONTAINED IN THE Pre-Draft Feasibility Report, DATED: June 1999

PROJECT: PROGRESSIVE NER PLAN - Jackson Hole, Wyoming, Environmental Restoration Project

LOCATION: Jackson Hole, Wyoming

DISTRICT: Walla Walla

P.O.C.: KIM CALLAN, CHIEF, COST ENGINEERING

		CURRENT MCACES ESTIMATE PREPARED: February 2000 EFFECTIVE PRICING LEVEL: 1 October 1999				AUTHORIZ./BUDGET YEAR: 2001 EFFECT. PRICING LEVEL: 1 OCT 00				........FULLY FUNDED ESTIMATE........				
ACCOUNT NUMBER	FEATURE DESCRIPTION	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	OMB (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	FEATURE MID PT	OMB (%)	COST ($K)	CNTG ($K)	FULL ($K)
	AREA 9 - CONSTRUCTION													
06.3--	Environmental Restoration Project	1,608	322	20%	1,929	6.7%	1,716	343	2,059	FY2002	3.3%	1,773	354	2,127
	Gravel Removal, Armoring, Brush Fence, Root Wads, Dikes													
	2nd Year	189	38	20%	227	6.7%	202	40	242	FY2003	6.7%	216	43	259
	3rd Year	189	38	20%	227	6.7%	202	40	242	FY2004	10.2%	223	44	267
	4th Year	189	38	20%	227	6.7%	202	40	242	FY2005	13.9%	230	46	276
	5th Year	189	38	20%	227	6.7%	202	40	242	FY2006	17.6%	238	47	285
	6th Year	189	38	20%	227	6.7%	202	40	242	FY2007	21.5%	245	49	294
	TOTAL CONSTRUCTION COSTS ===>	2,552	510	20%	3,063		2,726	543	3,269			2,925	583	3,508
01---	LANDS AND DAMAGES	57	11	20%	68	6.7%	61	12	73	FY2001		61	12	73
30---	PLANNING, ENGINEERING & DESIGN													
	Project Management													
	Planning & Environmental Compliance													
9.0%	Engineering & Design	230	46	20%	276	6.7%	245	49	294	FY2002	3.3%	253	51	304
	Engineering Tech Review & VE													
	Contracting & Reprographics													
	Engineering During Construction													
31---	CONSTRUCTION MANAGEMENT													
8.0%	Construction Management	204	41	20%	245	6.7%	218	44	262	FY2002	3.3%	234	47	281
06---	MONITORING													
4.0%	Monitoring	102	20	20%	123	6.7%	109	22	131	FY2010	33.9%	117	23	140
	TOTAL COSTS ===============>	3,145	629	20%	3,775		3,359	670	4,029			3,590	716	4,306

AREA 9 - CONSTRUCTION

THIS ESTIMATE IS BASED ON THE SCOPE CONTAINED IN THE Pre-Draft Feasibility Report, DATED: June 1999

PROJECT: PROGRESSIVE NER PLAN - Jackson Hole, Wyoming, Environmental Restoration Project — DISTRICT: Walla Walla

LOCATION: Jackson Hole, Wyoming — P.O.C.: KIM CALLAN, CHIEF, COST ENGINEERING

		CURRENT MCACES ESTIMATE PREPARED: February 2000 EFFECTIVE PRICING LEVEL: 1 October 1999				AUTHORIZ./BUDGET YEAR: 2001 EFFECT. PRICING LEVEL: 1 OCT 00				........FULLY FUNDED ESTIMATE........				
ACCOUNT NUMBER	FEATURE DESCRIPTION	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	OMB (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	FEATURE MID PT	OMB (%)	COST ($K)	CNTG ($K)	FULL ($K)
	AREA 1 - CONSTRUCTION													
06.3--	Environmental Restoration Project	4,024	805	20%	4,829	6.7%	4,294	859	5,153	FY2003	6.7%	4,582	917	5,499
	Gravel Removal, Armoring, Brush Fence, Root Wads, Dikes													
	2nd Year	417	83	20%	501	6.7%	445	89	534	FY2004	10.2%	491	98	589
	3rd Year	417	83	20%	501	6.7%	445	89	534	FY2005	13.9%	507	101	608
	4th Year	417	83	20%	501	6.7%	445	89	534	FY2006	17.6%	523	105	628
	5th Year	417	83	20%	501	6.7%	445	89	534	FY2007	21.5%	541	108	649
	6th Year			20%										
	TOTAL CONSTRUCTION COSTS ===>	5,692	1,138	20%	6,831		6,074	1,215	7,289			6,644	1,329	7,973
01---	LANDS AND DAMAGES	15	3	20%	18	6.7%	16	3	19	FY2002	3.3%	17	3	20
30---	PLANNING, ENGINEERING & DESIGN													
	Project Management													
	Planning & Environmental Compliance													
9.0%	Engineering & Design	512	102	20%	615	6.7%	547	109	656	FY2002	3.3%	565	113	678
	Engineering Tech Review & VE													
	Contracting & Reprographics													
	Engineering During Construction													
	Project Operation:													
31---	CONSTRUCTION MANAGEMENT													
8.0%	Construction Management / Monitoring (50%)	455	91	20%	546	6.7%	486	97	583	FY2003	6.7%	532	106	638
06---	MONITORING													
4.0%	Monitoring	228	46	20%	273	6.7%	243	49	292	FY2010	33.9%	266	53	319
	TOTAL COSTS ===============>	6,903	1,381	20%	8,283		7,366	1,473	8,839			8,023	1,604	9,628
	AREA 1 - CONSTRUCTION													

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PROJECT: PROGRESSIVE NER PLAN - Jackson Hole, Wyoming, Environmental Restoration Project
LOCATION: Jackson Hole, Wyoming

DISTRICT: Walla Walla
P.O.C.: KIM CALLAN, CHIEF, COST ENGINEERING

		CURRENT MCACES ESTIMATE PREPARED: February 2000 EFFECTIVE PRICING LEVEL: 1 October 1999				AUTHORIZ./BUDGET YEAR: 2001 EFFECT. PRICING LEVEL: 1 OCT 00				........FULLY FUNDED ESTIMATE.........				
ACCOUNT NUMBER	FEATURE DESCRIPTION	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	OMB (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	FEATURE MID PT	OMB (%)	COST ($K)	CNTG ($K)	FULL ($K)
	AREA 4 - CONSTRUCTION													
06.3--	Environmental Restoration Project	4,200	840	20%	5,040	6.7%	4,482	896	5,378	FY2004	10.2%	4,941	988	5,929
	Gravel Removal, Armoring, Brush Fence, Root Wads, Dikes													
	2nd Year	450	90	20%	539	6.7%	480	96	576	FY2005	13.9%	547	109	656
	3rd Year	450	90	20%	539	6.7%	480	96	576	FY2006	17.6%	565	113	678
	4th Year	450	90	20%	539	6.7%	480	96	576	FY2007	21.5%	583	117	700
	5th Year			20%										
	6th Year			20%										
	TOTAL CONSTRUCTION COSTS ===>	5,548	1,110	20%	6,658		5,922	1,184	7,106			6,636	1,327	7,963
01---	LANDS AND DAMAGES	83	17	20%	100	6.7%	89	18	107	FY2003	6.7%	95	19	114
30---	PLANNING, ENGINEERING & DESIGN													
	Project Management													
	Planning & Environmental Compliance													
9.0%	Engineering & Design	499	100	20%	599	6.7%	533	107	640	FY2003	6.7%	569	114	683
	Engineering Tech Review & VE													
	Contracting & Reprographics													
	Engineering During Construction													
	Project Operation:													
31---	CONSTRUCTION MANAGEMENT													
8.0%	Construction Management / Monitoring (50%)	444	89	20%	533	6.7%	474	95	569	FY2004	10.2%	531	106	637
06---	MONITORING													
4.0%	Monitoring	222	44	20%	266	6.7%	237	47	284	FY2010	33.9%	265	53	319
	TOTAL COSTS ================>	6,797	1,359	20%	8,156		7,255	1,451	8,706			8,096	1,619	9,716

AREA 4 - CONSTRUCTION

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PROJECT: PROGRESSIVE NER PLAN - Jackson Hole, Wyoming, Environmental Restoration Project — DISTRICT: Walla Walla

LOCATION: Jackson Hole, Wyoming — P.O.C.: KIM CALLAN, CHIEF, COST ENGINEERING

		CURRENT MCACES ESTIMATE PREPARED: February 2000 EFFECTIVE PRICING LEVEL: 1 October 1999				AUTHORIZ./BUDGET YEAR: 2001 EFFECT. PRICING LEVEL: 1 OCT 00				........FULLY FUNDED ESTIMATE.........				
ACCOUNT NUMBER	FEATURE DESCRIPTION	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	OMB (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	FEATURE MID PT	OMB (%)	COST ($K)	CNTG ($K)	FULL ($K)
	AREA 10 - CONSTRUCTION													
06.3--	Environmental Restoration Project	3,366	673	20%	4,040	6.7%	3,592	718	4,310	FY2005	13.9%	4,090	818	4,908
	Gravel Removal, Armoring, Brush Fence, Root Wads, Dikes													
	2nd Year	351	70	20%	421	6.7%	375	75	450	FY2006	17.6%	441	88	529
	3rd Year	351	70	20%	421	6.7%	375	75	450	FY2007	21.5%	456	91	547
	4th Year			20%										
	5th Year			20%										
	6th Year			20%										
	TOTAL CONSTRUCTION COSTS ===>	4,069	814	20%	4,883		4,342	868	5,210			4,987	997	5,984
01---	LANDS AND DAMAGES	84	17	20%	101	6.7%	90	18	108	FY2004	10.2%	99	20	119
30---	PLANNING, ENGINEERING & DESIGN													
	Project Management													
	Planning & Environmental Compliance													
9.0%	Engineering & Design	366	73	20%	439	6.7%	391	78	469	FY2004	10.2%	431	86	517
	Engineering Tech Review & VE													
	Contracting & Reprographics													
	Engineering During Construction													
	Project Operation:													
31---	CONSTRUCTION MANAGEMENT													
8.0%	**Construction Management**	326	65	20%	391	6.7%	347	69	416	FY2005	13.9%	399	80	479
06---	MONITORING													
4.0%	Monitoring	163	33	20%	195	6.7%	174	35	209	FY2010	33.9%	199	40	239
	TOTAL COSTS ================>	5,007	1,001	20%	6,009		5,344	1,068	6,412			6,115	1,223	7,338
	AREA 10 - CONSTRUCTION													

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LOCATION: Jackson Hole, Wyoming

DISTRICT: Walla Walla
P.O.C.: KIM CALLAN, CHIEF, COST ENGINEERING

ACCOUNT NUMBER	FEATURE DESCRIPTION	CURRENT MCACES ESTIMATE PREPARED: February 2000 EFFECTIVE PRICING LEVEL: 1 October 1999 COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	AUTHORIZ./BUDGET YEAR: 2001 EFFECT. PRICING LEVEL: 1 OCT 00 OMB (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	........FULLY FUNDED ESTIMATE........ FEATURE MID PT	OMB (%)	COST ($K)	CNTG ($K)	FULL ($K)
	SITE A													
06.3--	Environmental Restoration Project	2,085	417	20%	2,503	6.7%	2,225	445	2,670	FY2009	29.7%	2,885	577	3,462
	Gravel Removal, Armoring, Brush Fence, Root Wads, Dikes													
	2nd Year	168	34	20%	202	6.7%	180	36	216	FY2010	33.9%	241	48	289
	3rd Year	168	34	20%	202	6.7%	180	36	216	FY2011	38.4%	249	50	299
	TOTAL CONSTRUCTION COSTS ===>	2,422	484	20%	2,907		2,585	517	3,102			3,375	675	4,050
01---	LANDS AND DAMAGES	121	24	20%	145	6.7%	129	26	155	FY2008	25.5%	162	33	195
30---	PLANNING, ENGINEERING & DESIGN													
	Project Management													
	Planning & Environmental Compliance													
9.0%	Engineering & Design	218	44	20%	262	6.7%	233	47	280	FY2008	25.5%	292	59	351
	Engineering Tech Review & VE													
	Contracting & Reprographics													
	Engineering During Construction													
	Project Operation:													
31---	CONSTRUCTION MANAGEMENT													
8.0%	**Construction Management**	194	39	20%	233	6.7%	207	41	248	FY2009	29.7%	270	54	324
06---	MONITORING													
4.0%	Monitoring	97	19	20%	116	6.7%	103	21	124	FY2014	52.5%	135	27	162
	TOTAL COSTS ================>	3,052	610	20%	3,662		3,257	652	3,909			4,234	848	5,082
	SITE A													

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LOCATION: Jackson Hole, Wyoming — P.O.C.: KIM CALLAN, CHIEF, COST ENGINEERING

		CURRENT MCACES ESTIMATE PREPARED: February 2000 EFFECTIVE PRICING LEVEL: 1 October 1999				AUTHORIZ./BUDGET YEAR: 2001 EFFECT. PRICING LEVEL: 1 OCT 00				........FULLY FUNDED ESTIMATE.........				
ACCOUNT NUMBER	FEATURE DESCRIPTION	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	OMB (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	FEATURE MID PT	OMB (%)	COST ($K)	CNTG ($K)	FULL ($K)
	SITE B													
06.3--	Environmental Restoration Project	3,106	621	20%	3,727	6.7%	3,315	663	3,978	FY2006	17.6%	3,899	780	4,679
	Gravel Removal, Armoring, Brush Fence, Root Wads, Dikes													
	2nd Year	253	51	20%	303	6.7%	270	54	324	FY2007	21.5%	328	66	394
	3rd Year	253	51	20%	303	6.7%	270	54	324	FY2008	25.5%	339	68	407
	TOTAL CONSTRUCTION COSTS ==>	3,611	722	20%	4,334		3,855	771	4,626			4,566	914	5,480
01---	LANDS AND DAMAGES	79	16	20%	95	6.7%	84	17	101	FY2005	13.9%	96	19	115
30---	PLANNING, ENGINEERING & DESIGN													
	Project Management													
	Planning & Environmental Compliance													
9.0%	Engineering & Design	325	65	20%	390	6.7%	347	69	416	FY2005	13.9%	395	79	474
	Engineering Tech Review & VE													
	Contracting & Reprographics													
	Engineering During Construction													
	Project Operation:													
31---	CONSTRUCTION MANAGEMENT													
8.0%	**Construction Management**	289	58	20%	347	6.7%	308	62	370	FY2006	17.6%	365	73	438
06---	MONITORING													
4.0%	Monitoring	144	29	20%	173	6.7%	154	31	185	FY2011	38.4%	183	37	219
	TOTAL COSTS ===============>	4,449	890	20%	5,338		4,748	950	5,698			5,605	1,122	6,727

SITE B

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DISTRICT: Walla Walla

LOCATION: Jackson Hole, Wyoming
P.O.C.: KIM CALLAN, CHIEF, COST ENGINEERING

		CURRENT MCACES ESTIMATE PREPARED: February 2000 EFFECTIVE PRICING LEVEL: 1 October 1999				AUTHORIZ./BUDGET YEAR: 2001 EFFECT. PRICING LEVEL: 1 OCT 00				........FULLY FUNDED ESTIMATE.........				
ACCOUNT NUMBER	FEATURE DESCRIPTION	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	OMB (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	FEATURE MID PT	OMB (%)	COST ($K)	CNTG ($K)	FULL ($K)
	SITE C													
06.3--	Environmental Restoration Project	1,053	211	20%	1,263	6.7%	1,123	225	1,348	FY2012	42.9%	1,605	322	1,927
	Gravel Removal, Armoring, Brush Fence, Root Wads, Dikes													
	2nd Year	54	11	20%	65	6.7%	58	12	70	FY2013	47.6%	86	18	104
	3rd Year	54	11	20%	65	6.7%	58	12	70	FY2014	52.5%	88	18	106
	TOTAL CONSTRUCTION COSTS ===>	1,161	232	20%	1,394		1,239	249	1,488			1,779	358	2,137
01---	LANDS AND DAMAGES	62	12	20%	74	6.7%	66	13	79	FY2011	38.4%	91	18	109
30---	PLANNING, ENGINEERING & DESIGN													
	Project Management													
	Planning & Environmental Compliance													
9.0%	Engineering & Design	105	21	20%	125	6.7%	112	22	134	FY2011	38.4%	155	30	185
	Engineering Tech Review & VE													
	Contracting & Reprographics													
	Engineering During Construction													
	Project Operation:													
31---	CONSTRUCTION MANAGEMENT													
8.0%	**Construction Management**	93	19	20%	111	6.7%	99	20	119	FY2012	42.9%	142	29	171
06---	MONITORING													
4.0%	Monitoring	46	9	20%	56	6.7%	50	10	60	FY2017	68.1%	71	14	85
	TOTAL COSTS ================>	1,467	293	20%	1,761		1,566	314	1,880			2,238	449	2,687

SITE C

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LOCATION: Jackson Hole, Wyoming — P.O.C.: KIM CALLAN, CHIEF, COST ENGINEERING

		CURRENT MCACES ESTIMATE PREPARED: February 2000 EFFECTIVE PRICING LEVEL: 1 October 1999				AUTHORIZ./BUDGET YEAR: 2001 EFFECT. PRICING LEVEL: 1 OCT 00				........FULLY FUNDED ESTIMATE.........				
ACCOUNT NUMBER	FEATURE DESCRIPTION	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	OMB (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	FEATURE MID PT	OMB (%)	COST ($K)	CNTG ($K)	FULL ($K)
	SITE D													
06.3--	Environmental Restoration Project	2,733	547	20%	3,279	6.7%	2,916	583	3,499	FY2007	21.5%	3,543	708	4,251
	Gravel Removal, Armoring, Brush Fence, Root Wads, Dikes													
	2nd Year	145	29	20%	174	6.7%	154	31	185	FY2008	25.5%	193	39	232
	3rd Year	145	29	20%	174	6.7%	154	31	185	FY2009	29.7%	200	40	240
	TOTAL CONSTRUCTION COSTS ===>	3,022	604	20%	3,626		3,224	645	3,869			3,936	787	4,723
01---	LANDS AND DAMAGES	67	13	20%	80	6.7%	71	14	85	FY2006	17.6%	84	16	100
30---	PLANNING, ENGINEERING & DESIGN													
	Project Management													
	Planning & Environmental Compliance													
9.0%	Engineering & Design	272	54	20%	326	6.7%	290	58	348	FY2006	17.6%	341	68	409
	Engineering Tech Review & VE													
	Contracting & Reprographics													
	Engineering During Construction													
	Project Operation:													
31---	CONSTRUCTION MANAGEMENT													
8.0%	**Construction Management**	242	48	20%	290	6.7%	258	52	310	FY2007	21.5%	315	63	378
06---	MONITORING													
4.0%	Monitoring	121	24	20%	145	6.7%	129	26	155	FY2012	42.9%	157	31	189
	TOTAL COSTS ================>	3,724	745	20%	4,468		3,972	795	4,767			4,833	965	5,799
	SITE D													

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LOCATION: Jackson Hole, Wyoming

DISTRICT: Walla Walla

P.O.C.: KIM CALLAN, CHIEF, COST ENGINEERING

ACCOUNT NUMBER		FEATURE DESCRIPTION	CURRENT MCACES ESTIMATE PREPARED: February 2000 / EFFECTIVE PRICING LEVEL: 1 October 1999 — COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	AUTHORIZ./BUDGET YEAR: 2001 / EFFECT. PRICING LEVEL: 1 OCT 00 — OMB (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	........FULLY FUNDED ESTIMATE........ — FEATURE MID PT	OMB (%)	COST ($K)	CNTG ($K)	FULL ($K)
		SITE E													
06.3--		Environmental Restoration Project	301	60	20%	361	6.7%	321	64	385	FY2013	47.6%	474	94	568
		Gravel Removal, Armoring, Brush Fence, Root Wads, Dikes													
		2nd Year	11	2	20%	13	6.7%	12	2	14	FY2014	52.5%	18	3	21
		3rd Year	11	2	20%	13	6.7%	12	2	14	FY2015	57.5%	19	3	22
		TOTAL CONSTRUCTION COSTS ===>	323	65	20%	388		345	68	413			511	100	611
01---		LANDS AND DAMAGES	87	17	20%	104	6.7%	93	19	112	FY2012	42.9%	133	27	160
30---		PLANNING, ENGINEERING & DESIGN													
		Project Management													
		Planning & Environmental Compliance													
	9.0%	Engineering & Design	29	6	20%	35	6.7%	31	6	37	FY2012	42.9%	44	9	53
		Engineering Tech Review & VE													
		Contracting & Reprographics													
		Engineering During Construction													
		Project Operation:													
31---		CONSTRUCTION MANAGEMENT													
	8.0%	**Construction Management**	26	5	20%	31	6.7%	28	6	34	FY2013	47.6%	41	8	49
06---		MONITORING													
	4.0%	Monitoring	13	3	20%	16	6.7%	14	3	17	FY2018	73.7%	20	4	24
		TOTAL COSTS ===============>	478	96	20%	574		511	102	613			749	148	897
		SITE E													

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LOCATION: Jackson Hole, Wyoming — P.O.C.: KIM CALLAN, CHIEF, COST ENGINEERING

		CURRENT MCACES ESTIMATE PREPARED: February 2000 EFFECTIVE PRICING LEVEL: 1 October 1999				AUTHORIZ./BUDGET YEAR: 2001 EFFECT. PRICING LEVEL: 1 OCT 00				.........FULLY FUNDED ESTIMATE.........				
ACCOUNT NUMBER	FEATURE DESCRIPTION	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	OMB (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	FEATURE MID PT	OMB (%)	COST ($K)	CNTG ($K)	FULL ($K)
	SITE F													
06.3--	Environmental Restoration Project	2,733	547	20%	3,279	6.7%	2,916	583	3,499	FY2008	25.5%	3,660	732	4,392
	Gravel Removal, Armoring, Brush Fence, Root Wads, Dikes													
	2nd Year	145	29	20%	174	6.7%	154	31	185	FY2009	29.7%	200	40	240
	3rd Year	145	29	20%	174	6.7%	154	31	185	FY2010	33.9%	206	42	248
	TOTAL CONSTRUCTION COSTS ===>	3,022	604	20%	3,626		3,224	645	3,869			4,066	814	4,880
01---	LANDS AND DAMAGES	79	16	20%	95	6.7%	84	17	101	FY2007	21.5%	102	21	123
30---	PLANNING, ENGINEERING & DESIGN													
	Project Management													
	Planning & Environmental Compliance													
9.0%	Engineering & Design	272	54	20%	326	6.7%	290	58	348	FY2007	21.5%	352	70	422
	Engineering Tech Review & VE													
	Contracting & Reprographics													
	Engineering During Construction													
	Project Operation:													
31---	CONSTRUCTION MANAGEMENT													
8.0%	**Construction Management**	242	48	20%	290	6.7%	258	52	310	FY2008	25.5%	325	65	390
06---	MONITORING													
4.0%	Monitoring	121	24	20%	145	6.7%	129	26	155	FY2013	47.6%	163	33	195
	TOTAL COSTS ================>	3,736	747	20%	4,483		3,985	798	4,783			5,008	1,003	6,011
	SITE F													

THIS ESTIMATE IS BASED ON THE SCOPE CONTAINED IN THE Pre-Draft Feasibility Report, DATED: June 1999

PROJECT: PROGRESSIVE NER PLAN - Jackson Hole, Wyoming, Environmental Restoration Project
LOCATION: Jackson Hole, Wyoming

DISTRICT: Walla Walla
P.O.C.: KIM CALLAN, CHIEF, COST ENGINEERING

ACCOUNT NUMBER	FEATURE DESCRIPTION	CURRENT MCACES ESTIMATE PREPARED: February 2000 EFFECTIVE PRICING LEVEL: 1 October 1999 COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	AUTHORIZ./BUDGET YEAR: 2001 EFFECT. PRICING LEVEL: 1 OCT 00 OMB (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	FULLY FUNDED ESTIMATE FEATURE MID PT	OMB (%)	COST ($K)	CNTG ($K)	FULL ($K)
	SITE G													
06.3--	Environmental Restoration Project	2,061	412	20%	2,473	6.7%	2,199	440	2,639	FY2010	33.9%	2,945	589	3,534
	Gravel Removal, Armoring, Brush Fence, Root Wads, Dikes													
	2nd Year	108	22	20%	130	6.7%	116	23	139	FY2011	38.4%	160	32	192
	3rd Year	108	22	20%	130	6.7%	116	23	139	FY2012	42.9%	166	33	199
	TOTAL CONSTRUCTION COSTS ===>	2,278	456	20%	2,733		2,431	486	2,917			3,271	654	3,925
01---	LANDS AND DAMAGES	71	14	20%	85	6.7%	76	15	91	FY2009	29.7%	99	19	118
30---	PLANNING, ENGINEERING & DESIGN													
	Project Management													
	Planning & Environmental Compliance													
9.0%	Engineering & Design	205	41	20%	246	6.7%	219	44	263	FY2009	29.7%	284	57	341
	Engineering Tech Review & VE													
	Contracting & Reprographics													
	Engineering During Construction													
	Project Operation:													
31---	CONSTRUCTION MANAGEMENT													
8.0%	**Construction Management**	182	36	20%	219	6.7%	194	39	233	FY2010	33.9%	262	52	314
06---	MONITORING													
4.0%	Monitoring	91	18	20%	109	6.7%	97	19	116	FY2015	57.5%	131	26	157
	TOTAL COSTS ================>	2,827	565	20%	3,392		3,017	603	3,620			4,047	808	4,855

SITE G

THIS ESTIMATE IS BASED ON THE SCOPE CONTAINED IN THE Pre-Draft Feasibility Report, DATED: June 1999

PROJECT: PROGRESSIVE NER PLAN - Jackson Hole, Wyoming, Environmental Restoration Project
DISTRICT: Walla Walla

LOCATION: Jackson Hole, Wyoming
P.O.C.: KIM CALLAN, CHIEF, COST ENGINEERING

	CURRENT MCACES ESTIMATE PREPARED: February 2000 EFFECTIVE PRICING LEVEL: 1 October 1999					AUTHORIZ./BUDGET YEAR: 2001 EFFECT. PRICING LEVEL: 1 OCT 00				........FULLY FUNDED ESTIMATE.........				
ACCOUNT NUMBER	FEATURE DESCRIPTION	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	OMB (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	FEATURE MID PT	OMB (%)	COST ($K)	CNTG ($K)	FULL ($K)
	SITE H													
06.3--	Environmental Restoration Project	1,388	278	20%	1,666	6.7%	1,482	296	1,778	FY2011	38.4%	2,050	410	2,460
	Gravel Removal, Armoring, Brush Fence, Root Wads, Dikes													
	2nd Year	72	14	20%	87	6.7%	77	15	92	FY2012	42.9%	110	21	131
	3rd Year	72	14	20%	87	6.7%	77	15	92	FY2013	47.6%	114	22	136
	TOTAL CONSTRUCTION COSTS ===>	1,533	307	20%	1,840		1,636	326	1,962			2,274	453	2,727
01---	LANDS AND DAMAGES	96	19	20%	115	6.7%	102	20	122	FY2010	33.9%	137	27	164
30---	PLANNING, ENGINEERING & DESIGN													
	Project Management													
	Planning & Environmental Compliance													
9.0%	Engineering & Design	138	28	20%	166	6.7%	147	29	176	FY2010	33.9%	197	39	236
	Engineering Tech Review & VE													
	Contracting & Reprographics													
	Engineering During Construction													
	Project Operation:													
31---	CONSTRUCTION MANAGEMENT													
8.0%	**Construction Management**	123	25	20%	147	6.7%	131	26	157	FY2011	38.4%	182	36	218
06---	MONITORING													
4.0%	Monitoring	61	12	20%	74	6.7%	65	13	78	FY2016	62.7%	91	18	109
	TOTAL COSTS ================>	1,951	390	20%	2,341		2,081	414	2,495			2,881	573	3,454
	SITE H													

APPENDIX H

ENVIRONMENTAL ASSESSMENT

OF THE

JACKSON HOLE, WYOMING, ENVIRONMENTAL RESTORATION FEASIBILITY STUDY

NEW NEPA COMPLIANCE INFORMATION

April 2000

The attached Environmental Assessment and Draft Finding of No Significant Impact (FONSI) were prepared in the spring of 1999. The preferred plan (referred to in the draft Feasibility Study as the "Initially Proposed NER Plan") at that time addressed various construction tools to be used in the selected four sites (Areas 1, 4, 9 and 10). At that time, the proposed project covered approximately 5 miles of the 22-mile reach of the river that is bounded intermittently by Federal flood control levees. Subsequent to that evaluation, a decision was made to expand the area of the proposed project to encompass the entire 22-mile reach. The project expansion resulted from discussions during an Alternative Formulation Briefing and a site visit with Corps of Engineers, Headquarters personnel, in October 1999.

Walla Walla District received a recommendation to consider using the cost and benefit information gathered for the 5-mile study area (presented in the report as the "Initial Plan") as a proxy for the entire 22-mile reach. The rationale is that the engineering measures that would be used had already been identified, the benefits of the management measures had been measured, and the construction costs had been developed. The District could use the site-specific information to formulate a complete plan to restore the entire degraded area. The complete plan developed by the District is presented as the "Progressive Plan" in the draft Feasibility Study.

The proposed environmental restoration project is expected to be of increasing benefit as additional sites are approved, funded, and constructed. The project's objectives are enhanced by the proposal to include additional sites. The specific objectives of the project are to restore river channel stability, protect the remaining diverse habitats, restore diversity and sustainability to degraded habitats, and restore degraded habitats for threatened and endangered species.

The attached Environmental Assessment was centered on the evaluation of the tools and methods of construction. These same tools will be utilized in additional sites selected for construction in the project area. Since this project is designed with an adaptive management component, the type of tools used at each subsequent site will be greatly influenced by the success of the tools implemented in the first four sites. Monitoring is an important aspect of this project, and results will be incorporated into future site development.

The final FONSI will address the sites for which detailed evaluation and coordination is complete and also the process and schedule for any additional site-specific documentation and coordination determined necessary. The current NEPA documentation is sufficient to begin project construction of the first 4 sites, as each of the 12 sites has independent utility and are not interdependent. Any additional site-specific documentation or coordination needed on one or more of the eight additional sites is to be completed nearer time of scheduled implementation or construction, as part of the adaptive management strategy of this project.

DRAFT

FINDING OF NO SIGNIFICANT IMPACT

JACKSON HOLE, WYOMING, ENVIRONMENTAL RESTORATION

The U.S. Army Corps of Engineers (Corps), Walla Walla District, proposes to construct channel stabilization pools, off-channel pools, secondary channels, eco fences, spur dikes, rock grade control structures, place root wad logs, and remove gravel for environmental restoration in the Snake River at Jackson, Wyoming. The purpose of the project is to restore fish and wildlife habitat that was lost as a result of the construction, operation, and maintenance of levees constructed under the Jackson Hole Flood Control Project (Public Law 516, Flood Control Act of 1950), including levees constructed by non-Federal interests (Water Resources Development Act of 1986).

The U.S. Senate Committee on Environment and Public Works authorized in a Study Resolution of June 12, 1990, the Jackson Hole, River and Wetland Restoration Study, Wyoming, to determine the advisability of restoring fish and wildlife habitat. The levees reduced the available floodplain resulting in increased water velocities, unstable channel configurations, elimination of natural channel braiding, and erosion of islands and associated vegetation. Snake River fine-spotted cutthroat trout have been and continue to be affected by the loss of spawning areas and in-stream and over-wintering habitat. Spawning areas in the main river are reduced through scouring and in spring creeks due to debris blockages. Other habitat impacts for fish include the loss of shade, in-stream woody debris, and low-energy resting habitat. Terrestrial habitat has also been affected through the loss of shrub-willow and cottonwood riparian areas typically used by moose, elk, mule deer, furbearers, numerous small mammals, and various other wildlife species.

The Corps prepared an Environmental Assessment (EA) to evaluate the potential effects of restoration measures upon environmental resources and upon the Jackson Hole Flood Control Project. The purpose of the EA is to ensure actions and restoration measures proposed as a result of the study meet the requirements of the National Environmental Policy Act of 1969 and subsequent implementing regulations issued by the Council on Environmental Quality (40 CFR 15000) and the Corps' ER 200-2-2.

The Corps evaluated 4 alternatives in the EA, including the "no action" alternative. Alternative 1 included the comprehensive implementation of restoration measures throughout the 500-year floodplain at an unlimited number of areas. This broad approach to restoring aquatic and terrestrial habitat would implement measures between the levees, restore flows to spring creeks and vegetation outside of the levees, as well as maintain the base flood capacity. This comprehensive approach satisfied the purpose and need of the project. However, it proved to be

too comprehensive and, therefore, too costly for the local sponsor and was thus eliminated from further consideration.

A second alternative was developed to provide a similar comprehensive approach to restoring aquatic and terrestrial habitat and maintaining base flood capacity inside the existing levee system. Under this alternative, twelve specific areas were identified for implementation of restoration measures. This alternative satisfied the project purpose and need, but exceeded the local sponsor's fiscal capability. This alternative was also eliminated from further consideration.

A third alternative involved reducing the 12 specific sites to 4 specific sites that would have the greatest potential for restoring lost aquatic and terrestrial habitat and maintaining base flood capacity. To arrive at the four sites, the Corps conducted a multiple objective analysis. The analysis evaluated the areas on a number of elements including institutional recognition (national laws and regulations specific to the area), public recognition (environmental and economic value), and technical recognition (importance of spring creeks, spawning habitat, and eagle nesting). Additional analysis included the potential for channel creation for fisheries restoration, riparian island preservation and restoration, fish habitat creation, and spring creek restoration. It also included specific input from the scoping process, local input, and considerations of property ownership and cultural resources. The 4 sites selected were areas 1, 4, 9, and 10. This alternative satisfied the project purpose and need and was determined to be within the local sponsor's fiscal capability. Because this alternative would satisfy the project purpose and need and be within the local sponsor's fiscal ability, the Corps selected it as the preferred alternative.

Under the "no action" alternative, Alternative 4, the progressive loss of portions of the remaining aquatic and terrestrial habitat between the levees would continue. The Corps determined the "no action" alternative would not meet the purpose of the project or satisfy the need to prevent further loss of aquatic and terrestrial habitat and restore portions of habitat already lost. Although the "no action" alternative was not selected as the preferred alternative, the "no action" alternative would, by default, become the preferred alternative should the project not proceed to the construction phase.

The EA, along with appendices, which included a Biological Assessment, Coordination Act Report, Cultural Resource Evaluation and Section 404(b)(1) Evaluation, was distributed for public review during the period March 5 through April 6, 1999. The Corps received and responded to 7 comment letters. The comments were incorporated into our findings as a supplement to the EA and included in our evaluation. Those comments incorporated as additions to or modifications of the EA are noted in the attached Comment Response Package.

I have taken into consideration the technical aspects of the project, best scientific information available, public comment, and determinations of the EA. Based on this information, I have determined that the proposed action would not significantly affect the quality of the human environment, and that an Environmental Impact Statement is not required.

DATE: ______________

____
William E. Bulen, Jr.
Lieutenant Colonel, Corps of Engineers,
District Engineer

DRAFT

JACKSON HOLE, WYOMING
ENVIRONMENTAL RESTORATION PROJECT

COMMENT RESPONSE PACKAGE

DATE

JACKSON HOLE CONSERVATION ALLIANCE

3/29/99

ATTN: James S. Smith
Walla Walla District Corps of Engineers
Environmental Compliance Branch
201 N. 3rd Avenue
Walla Walla, Washington 99362-1876

Dear Mr. Smith,

I am writing on behalf of the Board of Directors and over 1,600 members of the Jackson Hole Conservation Alliance (JHCA) in regards to the Jackson Hole, Wyoming Environmental Restoration Project Environmental Assessment (EA). We are intrigued by the proposal and think that the concept for an aquatic and habitat restoration project within the Snake River Levee system is a good idea. Having worked with the Army Corps of Engineers for years to try to gain public acceptance for restoration activities, JHCA recognizes the potential benefits of this project. However, in reading through the EA, in some cases we were left wondering whether the ends justified the means. Therefore, while we support the overriding goal of the Snake River Environmental Restoration Project, we hope that some of the details can be amended as to minimize intrusion into the river and maximize positive results.

1 1. The Corps must take full responsibility for monitoring the pilot project currently in operation before it finalizes and undertakes the proposed project. What is being done to document the successes and failures of the pilot project? From our perspective, it is important to know what aspect of the pilot project are working and which ones are not working in order to produce the most effective restorative capabilities of the four sites proposed for restoration activities. Any problems identified through the monitoring activities should be addressed with proposed solutions.

2 2. We would like to see an accurate timeline describing when there would be scheduled work activity in the project areas. The EA is unclear in describing the work schedules for each project area and JHCA would like to see those concerns addressed to ensure that the needs for wildlife migration and threatened and endangered species are considered in the work plan.

3 3. As outlined, we are concerned about the gravel removal process from the project area. Can we get some assurances that the gravel removal process associated with this proposal will be driven by the river itself and not the gravel needs of the excavator? Having driven over the Wilson bridge all winter, the site of the pilot project, it appeared that gravel trucks were in the river an excessively long time. Is there any analysis of impacts (scenic, social, wildlife, and other) of a back hoe removing substantial amounts of gravel in the river for an extended period of time?

4 4. In the "Project Purpose and Need" section of the Environmental Assessment, the Corps states, "The project has high potential for restoring fish and wildlife habitat through enhancement and restoration of the aquatic and terrestrial environment, including wetland and riparian vegetation and in-stream fisheries habitat." Is there

P.O. Box 2728 Jackson, WY 83001 (307) 733-9417 FAX (307) 733-9008 E-mail: jhca@wyoming.com Web page: http://www.jhalliance.com

any proof or any documentation of other projects that have undertaken similar activities and been successful? JHCA feels that the Corps needs to make sure that this prediction comes true through the current pilot project before undertaking the remaining projects so there is opportunity to make adjustments based on the success or failure of the pilot.

5 5. We are also concerned about the various access points for each of the project areas. Is there a map outlining where these access points will occur and possible impacts upon vegetation and wildlife?

6 6. What safety issues are there pertaining to eco-fences? Will there be a safety issue for boaters and fisherman wading in the river near eco-fences? How are these areas going to be marked so recreationist can identify them?

All and all, JHCA supports this project and the projected goals for restoring habitat in the area impacted by the Snake River Levees. We just want to make sure that this project does not do more damage in its efforts to reverse past damage. We think that the chance of this could be minimized by applying lessons from the pilot project to the additional project areas proposed for restoration activities.

Sincerely,

Mac Munro
Issues Assistant

Pam Lichtman
Program Director

Response to March 29, 1999 letter from Jackson Hole Conservation Alliance

Comment 1 – Teton County undertook the demonstration or pilot project separate from the Jackson Hole, Wyoming Environmental Restoration Project Feasibility Study which they co-sponsor with the Corps. The Corps' funding authorizations do not include implementation or monitoring of the demonstration project. Assessment of the demonstration project's effects upon fisheries, water quality, vegetation, and physical changes in topography would be conducted or coordinated by Teton County. The extent of monitoring, including selected items, methods, and duration will be limited to those requirements established under Teton County's Clean Water Act, Section 404 Permit and any other parameters which Teton County may choose to monitor. Any results of their monitoring and assessments would be provided to the Corps for consideration during subsequent planning, engineering, and designing of restoration tools for the 4 restoration sites. See response to April 9, 1999 letter from Wyoming Game and Fish Department, Comment 5.

Comment 2 – Multiple factors relating to water flows and activities of particular wildlife species would restrict the timeline or schedule. These restrictions are addressed throughout the text of the Environmental Assessment (EA) as well as in the Biological Assessment (BA), Appendix A to the EA. Construction activity would principally be limited to periods of low river flows. The low flow period will vary based on seasonal influences. Most work would be expected to occur during the period August 15 through November 15, however, the period could be shorter or longer. Other influences which may further restrict scheduling include factors related to the presence of migratory big game, avian nesting activity, and activities of endangered species such as the bald eagle, peregrine falcon, whooping crane, grizzly bear and gray wolf. Because of these multiple potential influences upon construction activity, a fixed schedule is not possible.

Comment 3 – Gravel removal will be limited to that which is necessary to construct the restoration tools and to compensate for decreases in the base flood capacity resulting from restoration measures. The quantity of gravel removal will vary from tool to tool and from site to site. Excavations to retain channel capacity and construct channel stabilization pools as well as excavations to perform maintenance will be based upon hydrological analyses. Implementation of maintenance measures will be subject to the same restrictions applicable to the original construction.

Comment 4 – Use of eco fences, secondary channels, and off-channel pools to restore fish and wildlife habitat in a high energy environment such as exists at the four restoration sites is essentially a new approach. Spur dikes and anchored root wad logs are widely known methods for diversifying fisheries habitat. See response to comment 1.

Response to Jackson Hole Conservation Alliance (Cont'd)

Comment 5 – Access to the general construction sites is discussed in paragraph 6.6 of the EA. Access where existing roads are not available would be coordinated in the field by Corps' personnel, a representative for the levee flood control project and appropriate landowners. Routes will be selected to avoid or minimize impacts to vegetation.

Comment 6 – Paragraph 6.8 of the EA addresses effects of construction, presence of completed structures, and maintenance upon recreational activity. As indicated in the EA, the local sponsor would implement a public information campaign to inform the recreating public about the project and how to recognize structures. Because some structures may be less readily recognizable due to variable conditions from site to site, marking of some structures may be appropriate. The Corps and local sponsor would evaluate the need for marking of certain structures. The local sponsor would erect signage deemed necessary as part of their public information campaign.

Edward R. and Shirley J. Cheramy
970 West Broadway, #438
Jackson, Wyoming 83001-9475
Phone: (307) 739-2157 Fax: (307) 733-2931

March 30, 1999

Walla Walla District
U.S. Army Corps of Engineers
Environmental Compliance
201 N. 3rd Avenue
Walla Walla, WA 99362-1876

Re: Snake River Restoration Project

ATTN: James S. Smith

Ladies and Gentlemen:

We live in Study Area 4 of the Snake River Restoration Project. Our eastern property line is the Snake River. We have attended all of the meetings related to this Project, have read the Environmental Assessment and have had discussions with various officials associated with this Project. We consider ourselves, as "laymen", to be thoroughly familiar with this Project.

1 We strongly support this Snake River Restoration Project and encourage you to begin work on its full implementation as soon as possible. We see no negative consequences to this project. In fact, we see negative consequences if the Project is NOT done.

Please feel free to call us at 307-739-2157 if you would like to discuss this further.

Sincerely,

Edward R. Cheramy

Shirley J. Cheramy

Response to March 30, 1999 letter from Edward R. and Shirley J. Cheramy

Comment 1: Thank you for your comment.

Rec'd 7-

Sewell Partners
4445 Moose Wilson Road
Wilson, Wyoming 83014
(307) 733-3989

April 1, 1999

Mr. James S. Smith
Walla Walla District Corps of Engineers
Environmental Compliance Branch
201 N. 3rd Ave.
Walla Walla, WA 99362-1876

Re: EA on Jackson Hole Restoration Project

Dear Mr. Smith:

Sewell Partners owns property along the right bank of the Snake River
adjacent to the Taylor Creek #3 and Sewell Levees. Sewell Partners has been
1 and continues to be materially affected by the levee operation and
maintenance of the Corps of Engineers. This proposed restoration project
would also materially affect us.

The cover letter to the EA states that "The purpose of this project is to restore
fish and wildlife habitat lost as a result of construction, operation, and
2 maintenance of the levees constructed under the Jackson Hole Flood Control
Project..." We support this purpose and would like to see the project proceed,
but not in the piece meal fashion proposed. The Corps of Engineers has again
analyzed a small portion of the situation and refused to look at the whole.

This is a major federal action with many significant impacts. The proposed
action would significantly affect the quality of the human and natural
3 environment, and therefore an Environmental Impact Statement is required
pursuant to the NEPA. There are many reasons that this EA is inadequate
and that an EIS is required, but I will list only a few prominent ones.

4 This action is being considered piece meal: it should be analyzed
together with the ongoing maintenance, repair, and extensions of the existing
levees maintained by the Corps of Engineers.

The no action alternative was summarily rejected without sufficient
5 analysis. How can one compare the proposed alternative to the no action
when it is not included?

The alternative of protecting similar habitat that still exists along the
banks of the river but is unprotected by levees was not analyzed. If this EA
6 had looked at the whole flood plain instead of just the river channel, this
alternative would have been obvious and would have proved to be more cost
effective.

7 No significant analysis is given to the cumulative effects of this project when considered in the appropriate context of the overall levee system.

8 A finding of no significant impact is not supportable, and definitely is not supported by this EA. The Corps of Engineers should begin a full EIS process in the context of the whole Jackson Hole Flood Control Project.

Sincerely,

William B. Resor
general and managing partner
Sewell Partners

Response to April 1, 1999 letter from Sewell Partners

Comment 1: Thank you for your comment.

Comment 2: See response to April 6, 1999 letter from United States Department of the Interior, Bureau of Land Management, Comment 1.

Comment 3: See response to April 6, 1999 letter from United States Department of the Interior, Bureau of Land Management, Comment 1.

The Corps does not believe the proposed restoration measures warrant the level of analysis required of an Environmental Impact Statement. The proposed measures will not add to the baseline negative impacts attributable to the levees. The project is intended to diminish levee impacts by restoring portions of lost fish and wildlife habitat. We disagree that the project is being conducted in a piece-meal fashion. Past attempts to study opportunities for implementing restoration measures have been systematic within the limits of available time and funds and have considered areas both inside and outside the levees within the 500-year floodplain along approximately 25 miles of the Snake River. The Corps evaluated cumulative effects of the alternatives and determined the project has potential for beneficial effects regardless of whether the project encompasses one or numerous sites within the 500-year floodplain.

Those areas removed from further consideration due to limitations imposed by the agreement with the local sponsor are not precluded from future study. The Corps is hopeful that restoration measures at other areas along the Snake River may be studied and implemented in cooperation with a local sponsor.

Comment 4: See response to Comment 3 and response to the April 6, 1999 letter from United States Department of the Interior, Bureau of Land Management, Comment 1.

Cumulative effects are discussed in paragraph 6.11 of the EA. The Corps determined the proposed action would not add to the cumulative adverse effects caused by previous flood control actions at each of the 4 proposed restoration sites. In some instances, changes caused by the cumulative effect of actions proposed would cause non-beneficial effects of past flood control activities to diminish. Some restoration tools, such as spur dikes and bank barbs, were selected on the basis of their potential to lessen adverse effects of the river upon existing levees. The proposed action has significant potential for reducing erosion and damage of the levees in the immediate vicinity of each restoration site. Considerable opportunity for reduced levels of levee maintenance and repair could result.

Comment 5: See response to April 6, 1999 letter from United States Department of the Interior, Bureau of Land Management, Comment 1.

Response to April 1, 1999 letter from Sewell Partners (Cont'd)

Comment 6: See response to April 6, 1999 letter from United States Department of the Interior, Bureau of Land Management, Comment 1.

Comment 7: See response to Comment 3 and response to April 6, 1999 letter from United States Department of the Interior, Bureau of Land Management, Comment 1.

Comment 8: See response to comment 3.

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Pinedale Resource Area
P.O. Box 768
Pinedale, Wyoming 82941-0768

WY (100)
1813

April 6, 1999

Peter F. Poolman
Planning Division, Department of the Army
Walla Walla District, Corps of Engineers
201 North Third Avenue
Walla Walla Washington 99362-1876

Dear Mr. Poolman:

Thank you for the opportunity to comment on the Environmental Assessment for the proposed Jackson Hole, Wyoming Environmental Restoration Project. As you are likely aware, all of the four areas proposed for the restoration project contain at least a small amount of BLM public land. Therefore, we are very interested in any planned activities in these areas.

Comments from our staff are attached. We look forward to seeing the final EA and FONSI.

Sincerely,

Leslie A. Shew

Field Manager

Enclosure

Bureau of Land Management, Pinedale Field Office
Comments on the Environmental Assessment for the Jackson Hole, Wyoming Environmental Restoration Project

	Page	Paragraph	Line	Comment
1	2	1-3		No reasonable alternatives to the proposed action are discussed; even the no action alternative was dropped from further consideration. The EA does not consider an adequate range of alternatives.
2	3-1	4	5	Spelling: *Oncorhynchus clarki*. Many other spelling errors occur throughout the text.
3	5-1	4	6-7	A permit will be required in order for any gravel to be removed from BLM lands. Depending on the type of permit granted, there may be stipulations on what uses the gravel may be put to after removal from the stream. All four Areas include at least a small amount of BLM land; it may be quite difficult to determine the ownership of gravels removed from the channel during construction.
4	5-10	1		During the life of the project, permits for removal of gravel from BLM lands will be necessary, including during maintenance activities.
5	6-13	1	1	Other parts of the document state that the project will allow island revegetation, reforestation, etc. This section says that "there may be enough protection in some areas to allow for langer survival of some plant species". This statement is not very strong, considering the stated goals of the project.
6	6-13	5	1	Replace "The trend of the habitat unit increases..." with "The trend of future habitat values increases..."
7	6-14	3	13	Monitoring will not ensure that weeds do not spread. Noxious weeds will be encountered in the project area. What is the plan for ensuring that weeds are not spread through both the project area and Jackson Hole?
8	6-20	1		Add wolf to the list of mammals that frequent Jackson Hole.
9	6-22	4	10	Should the lynx be moved the the T&E section?

10	6-39	3		This paragraph confuses the different restrictions on camping and other activities. As part of the lawsuit settlement, almost all the private lands along the river carry recreational easements granted to the BLM. The recreational restrictions on these lands are spelled out in the settlements and judgements. In general, boating, wading, hiking, picnicking, etc. are allowed, while shooting, hunting, open fires, and camping are not. These restrictions do not apply to the BLM lands; however, all the BLM lands were closed to camping several years ago to end chronic problems with summer employees living on the BLM lands.

11 **Concerning the sentence on pg. 5-2,** "The 4-inch minus material would be transported from the screening location by truck for **off-site upland disposal** prior to anticipated high flows" **and the sentence on pg. E-9 in Appendix E,** "Cobble, gravel, and sand not screened would be transported by truck to a permitted gravel processing facility for **disposal**." The question is, "Does **disposal** mean gravel sales by either the sponsor or contractor?" Any gravel that is obtained from public lands administered by the BLM and where permission to mine has been granted by a "Free Use Permit (FUP)," the extracted gravel must be used within the Project or for other public uses. The gravel may not be sold to help finance the Jackson Hole Restoration Project unless the local sponsor obtains, instead of a FUP, a "Negotiated Sale" BLM permit by paying "fair market value." In this case, the sponsor would need to purchase the gravel at the appraised value, probably between $0.75 and $1.50 per cubic yard. The BLM State Office would then to complete an appraisal to determine that fair market value.

The above statements also supply additional information for the sentences on pg. 7-4, "A permit must be obtained from the BLM prior to initiation of gravel removal from lands administered by that agency. The local sponsor would obtain the permit."

12 **Section 7.1.7 Wild and Scenic Rivers Act on pg. 7-2** probably needs to be further expanded or evaluated. I supply the following information for consideration:

I conducted a search of our office's Master Title Plats (MTP) covering the project area including townships 40N-116W, 40N-117W, 41N-116W, 41N-117W, and 42N-116W. These plats show land status and actions. The Snake River was designated a "Study River" from the southern boundaries of Teton National Park to the entrance to Palisades Reservoir under the Wild and Scenic Rivers Act. The MTP show that all townships except 41N-117W and 40N-117W have a Wild and Scenic Rivers Withdraw under Public Law 93-621 (WYW52152). The Withdraw states that "All public lands which constitute the bed or bank, or are within one-quarter mile of the bank, of any river which is listed in section 5 (study rivers) of this Act are hereby withdrawn from entry, sale, or other disposition under the public land lands of the United States for the period specified in section 7, subsection (b) of this Act." It is my understanding that these withdraws are still valid until Congress acts to either delete or select any portions of the study river. Until an "Opening Order" is issued to revoke the original withdraw, what is shown on the MTP is still valid. All of the Project area is free of these

Wild and Scenic River withdraws with the exception of public lands within Area 10 at the junction of the Gros Ventre and Snake Rivers (Secs 5-7, 18 of T.41N., R.116W. and Secs 2-4,9-10,16-17,20-21,28-29,31-32 of T.42N., R.116W.). It may be that the authority in the Flood Control Act of 1950 and the Water Resources Development Act of 1986 to build and maintain levees for flood control supersedes any Wild and Scenic Withdrawns in order to restore the original nature of the Snake River with its Scenic values.

Anyway, it is the author's opinion that the Wild and Scenic Withdraws of public lands described on the MTP have very restricted mineral material extraction authority and are like BLM's Wilderness Study Areas (WSA's) that do not allow mineral entry until Congress acts one way or the other to include those lands into the system. I may also make note that the BLM published in the Federal Register on June 1, 1995, Public Land Order 7143 (WYW 128871) that withdrew 5,937 acres of public lands and federal minerals along the Snake River for a period of 10 years. This action is to protect and preserve highly significant recreation, scenic, riparian, and wildlife resources until the BLM can complete a Land Use Plan (the Snake River RMP). The BLM is currently working on that NEPA document. The PLO described lands are withdrawn from settlement, location or entry under the mining laws, but not from leasing under the mineral leasing laws, exchange, or sales.

13 The Jackson Hole Wyoming Environmental Restoration Project has the potential to provide a limited amount of increased stability to portions of the Snake River channel but it does not address the root causes of the problems. However, within the constraints presented by society and available funding, the limited actions proposed could be more beneficial than taking no action.

14 The Snake River in the Jackson Hole area has several aspects that prevent the total recovery of the channel. The most prominent being the loss of the floodplain and the subsequent high dollar development behind the levies that prevents reallocation of land use to a more stable configuration. This, in combination with the past history of flow regulation from Jackson Lake Dam has produced a stream channel that is shorter and thus steeper than it would naturally be. As a result, there is excessive sediment transport and erosion of established channel features between the levees.

15 The proposed restoration projects do not significantly lengthen the channel but do make an attempt to reduce erosion by manipulating the flows from Jackson lake, deepening some portions of the channel, hardening some locations with structures, and increasing the average size of some of the sediment. If vegetation establishes behind some of the protected areas these changes may provide a measure of protection but will still require an active maintenance program.

16 Given the existing conditions between the levees, such actions have a greater potential to help than harm. They will not be the final solution to the problems along the Snake River but it is better than doing nothing.

Response to April 6, 1999 letter from United States Department of the Interior, Bureau of Land Management

Comment 1: The Corps previously evaluated, in an Environmental Assessment prepared under the authority of the 1986 Water Resources Development Act (Public Law 99-662), Section 1135(b), as amended, the potential of implementing environmental restoration measures outside of the levees. The Federal easements for access to private property outside of the levees, necessary to implement restoration measures, were not available. Consequently, the local sponsor withdrew sponsorship of the project and requested the Corps conduct a General Investigation Study to consider implementing restoration measures between the levees.

In June 1993, the Corps completed a Reconnaissance Report that concluded there to be a Federal interest in continuing the study of environmental restoration through the feasibility phase. The local sponsor subsequently entered into a cost-share agreement with the Corps to investigate the feasibility of implementing environmental restoration from Moose, Wyoming to the South Park feed grounds near Jackson, Wyoming. In January 1995, the Corps' responded with a Project Study Plan proposing restoration throughout the entire 500-year floodplain. The local sponsor rejected this alternative due to cost. Subsequently, evaluation was conducted to narrow the range of alternative sites to twelve. This significantly reduced the cost; however, it still proved to be outside of the sponsor's fiscal ability. Following further evaluation, the range of alternative locations was reduced to four. This proved to be within the sponsor's fiscal ability.

Because the current agreement restricts restoration measures to areas between the levees, alternatives that consider restoration measures outside of the levees were eliminated from further consideration. The parameters of that agreement also narrow the array of available tools to those most appropriate for in-channel siting.

During this process, the Corps' analysis determined Alternative 3, the preferred alternative, to be reasonable and feasible.. We also determined Alternatives 1 and 2 would be reasonable and feasible if money and time were of no consequence. All three alternatives would satisfy the project's purpose and need. Implementation of restoration measures at all areas adversely affected by the levees would appropriately address levee impacts upon the Snake River system. However, as indicated, such an approach was found to be unreasonable due to cost, resulting in the elimination of Alternatives 1 and 2. This also restricted the array of available tools to those most appropriate for in-channel siting between the levees.

The no action alternative was evaluated and eliminated from further consideration at the same time the other non-preferred alternatives were considered and eliminated. The no action alternative is also reasonable and feasible, however, it fails to satisfy the project's purpose and need. Should the local sponsor not choose to enter into construction, the no action alternative would become the selected alternative by default.

Response to April 6, 1999 letter from United States Department of the Interior, Bureau of Land Management (Cont'd)

The Corps recognizes the potential benefits of implementing alternate restoration measures at alternative locations outside of the levees and is hopeful local sponsorship of a study to evaluate and implement such an endeavor may occur in the future.

Comment 2: Your comment is noted and incorporated here as a revision to the EA.

Comment 3: Your comment is noted and incorporated here as a revision to the EA.

Comment 4: Your comment is noted and incorporated here as a revision to the EA.

Comment 5: This language is intended to acknowledge that the restoration tools may provide enough protection to allow longer survival of some plant species and thereby benefit the river by providing bank stability and organic matter. The restoration tools are intended to address the habitat degradation that has occurred within the leveed sections. Because the tools would be implemented in an environment where increased velocities have caused the loss of vegetation, reestablishment may occur rapidly, in very small increments, or, depending upon actions of the river, not at all at some restoration tools. Certain sites will experience a greater vegetation survival rate and experience greater longevity than will others.

Comment 6: Your comment is noted and incorporated here as a revision to the EA.

Comment 7: Teton County operates a Weed and Pest District. The local sponsor would coordinate with the Weed and Pest District on management of noxious weeds.

Comment 8: Your comment is noted and incorporated here as a revision to the EA.

Comment 9: Lynx was not a listed species under the Endangered Species Act (ESA) at the time the EA was drafted. Table 6-5 of the EA identifies lynx as a Priority III species as defined by the State of Wyoming. The lynx was evaluated along with other wildlife species in the area and potential effects are included in the EA. Should Lynx be formally listed under ESA the biological assessment would be updated to reflect the change in listing and any required consultation would be conducted.

Comment 10: Your comment is noted and incorporated here as an addition to the EA.

Comment 11: Thank you for requesting clarification. Gravel excavated from lands administered by BLM would either be used within the project or for public uses only. Gravel excavated from private lands would either be used within the project or would be transported to a permitted gravel processing facility for disposal.

Response to April 6, 1999 letter from United States Department of the Interior, Bureau of Land Management (Cont'd)

Comment 12: The Corps contacted BLM's regional office in Cheyenne, Wyoming and determined that the Wild and Scenic Withdraws are no longer valid.

Comment 13: Thank you for your comment.

Comment 14: Thank you for your comment.

Comment 15: Thank you for your comment.

Comment 16: Thank you for your comment.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 8
999 18TH STREET - SUITE 500
DENVER, CO 80202-2466

APR -5 1999

Ref: 8EPR-EP

James S. Smith
Walla Walla District Corps of Engineers
Environmental Compliance Branch
201 N. 3rd Avenue
Walla Walla, Washington 99362-1876

Dear Mr. Smith:

This letter is in response to your request for comments on the Environmental Assessment (EA), Section 404(b)(1) Evaluation, and draft Finding of No Significant Impact for the proposed Jackson Hole, Wyoming, Environmental Restoration Project. The Environmental Protection Agency, Region 8, (EPA) appreciates the opportunity to comment at this time. We strongly agree with the Corps that the Snake River floodplain in the Jackson Hole valley has been greatly modified by the construction of federal and private levees. We want to point out that the modifications continue to occur as a result of Corps and private actions and all efforts should be taken by the Corps to assure that further encroachment into the floodplain does not occur. EPA believes every effort should be made to avoid such impacts rather than have to conduct "restoration" programs in the future. We also believe there are opportunities when existing
1 levees fail to allow the river to seek a natural path rather than reconstruct the levee. Perhaps this EA should document the areas where this potential occurs, the institutional or environmental constraints if any, and options to overcome them.

In the EA it is stated that several alternatives and actions were rejected due to cost. The EA needs to include the actual cost information which was used to reject various actions so that the reader can understand the significance of the cost issues. As cost seems to be the primary reason cited for selection of the preferred alternative, the EA should discuss options to modify
2 the costs of the alternatives as well as opportunities to seek cost reimbursement from other sources. As the "science" of channel restoration is new and continually evolving, the EA needs to also present the costs for the various "tools" to be used for the channel restoration. This is very important information because it allows the reader to compare this effort to other channel restoration efforts. This will allow future efforts to better select the most appropriate method for channel restoration of this nature.

The EA (page 5-8) indicates that the post project monitoring plan would be developed prior to completion of the restoration project. EPA strongly believes that this plan needs to be
3 developed and agreed to by all the affected parties prior to project construction, and should have been part of the EA so that public comment could have been received. The post-project

monitoring plan is one of the most critical parts of this project. Without detailed, long-term biological monitoring, it will not be possible to determine if the project purpose has been achieved. The implication of the EA is that major improvements in fisheries and cottonwood gallery habitat will occur because of the project. It will take many years of concentrated monitoring to determine if changes in fish standing crop and/or cottonwood recruitment success are attributable to the project features. The Corps should not underestimate the difficulty of this monitoring task, nor the long term cost. The EA indicates that the local sponsor will be required to conduct the monitoring and maintenance. The monitoring and maintenance plan needs to be finalized prior to, and included as part of the public works cost share agreement for this project. Without such sponsor commitment it is EPA's conclusion that a Finding of No Significant Impact cannot be reached.

On page 4-3 the EA indicates that gravel transport and deposition in the project area has decreased since completion of the levees. However, on page 5-9, the maintenance discussion indicates that maintenance of the channel stabilization pools, secondary channels, and off-channel pools will be necessary because they will fill with material being transported downstream. It is EPA's understanding that the Snake River in this area is still actively aggrading and this apparent conflict needs to be better explained. The discussion of the project maintenance requirements seems to indicate that this project may require a great deal of
4 maintenance for a very long period just to determine that the project goals (improved fisheries/cottonwood regeneration) will occur. We could not locate any case histories in the document discussing how long it may take the excavated project features to fill in. The Corps should examine other similar activities in area streams (instream gravel mining, levee repair, etc.) to determine the periodicity that instream maintenance may be required, and the potential costs of such maintenance. If the amount of material to be removed is large, the document needs to specify a disposal area, and the impacts at the disposal area.

Related to monitoring and maintenance, the current Teton County current stream restoration project at the Wilson Bridge was built with the primary purpose of determining if
5 these types of restoration structures would work. EPA does not believe that the proposed Corps project should be built until actual effectiveness, cost, and longevity data obtained at the Wilson Bridge demonstration is published and evaluated.

The hydrology discussion in section 6.1 of the EA does not supply information about the percent of time, or frequency that the flows will cause erosion/sedimentation of the proposed restoration structures. This is an important issue since if the excavated channel pools are refilled
6 on a regular basis the project benefits will not occur and project maintenance will be high, for negligible gains. From a vegetation perspective the created islands would need to be maintained for many years before mature cottonwoods could develop. The hydrology section should present the projected discharge at which the individual restoration features would fail, and the frequency at which that discharge is projected to occur.

The EA also contains a Clean Water Act §404(b)(1) evaluation in Appendix E. The
7 §404(b)(1) Guidelines (40 C.F.R. 230) provide the substantive requirements for this evaluation. At §230.5 there are procedures which should be followed to conduct the evaluation. One of the

principal efforts of a §404(b)(1) evaluation is the project purpose statement. This is the statement on which the alternatives selection is to be based, and the subsequent evaluation for compliance with the restrictions (§230.10) made. We agree with the first sentence of the purpose statement contained at 1(c) of the evaluation and recommend that the project purpose be limited to that single statement. The second sentence of 1(c) tends to confuse the issue. We saw no indication in the EA of methods to "preserve or enhance" the project area. Perhaps it is a matter of semantics, but "restoration" should be used for activities that restore degraded systems to their natural potential. "Enhancement" should be reserved for activities that enhance functioning systems beyond their natural potential.

An essential part of the evaluation which is not included in Appendix E is the alternatives
analysis. We recognize that the EA contains information on alternatives, and we noted some
areas above where the existing alternatives analysis needs to be improved. However, we do not
see in the EA where all practicable alternatives to restoring habitat lost by levee construction
8 have been included. For example, it would seem logical that since a major loss recognized in the
EA is cutthroat spawning habitat, at least one alternative of opening access to a single spring
stream somewhere within the levee system should be evaluated. The current proposal does little
to supply increased spawning areas, although it may assist recruitment if it can provide additional
protection for young-of-the-year. However, if recruitment is the actual project purpose, then
other management tools to increase recruitment need to be evaluated. And we do not see the
9 necessary evaluation showing that the least damaging, practicable alternative has been selected.
To be complete the evaluation should pay particular attention to the factors discussed at §230.12.

Again, we appreciate the opportunity to comment at this draft stage of the NEPA process and we look forward to working with the Corps as this project continues. If you have questions concerning our comments please contact Dave Ruiter at 303/312-6794.

Sincerely,

Cynthia Cody, Chief
NEPA Unit
Ecosystem Protection Program

cc: Mike Long, USFWS Cheyenne
Bill DiRienzo, WDEQ Cheyenne
Matt Bilodeau, Corps Cheyenne

Response to April 8, 1999 letter from United States Environmental Protection Agency

Comment 1: This environmental restoration project is being studied under the authority of the Study Resolution referenced in Paragraph 1.0 of the EA. The resolution directs the Corps to determine the advisability of compensating for fish and wildlife impacts resulting from construction, operation, and maintenance of the levees. Based on the language contained in the Resolution, the Corps believes considerations of alternatives for dealing with levee breaks are precluded from this study.

Additionally, the Corps feels that failure to maintain the levees would be contrary to Section 840 of the Water Resources Development Act of 1986. This Act authorizes the Corps to operate and maintain levees constructed under authority of the Flood Control Act of 1950, including levees constructed by non-Federal interests.

Comment 2: The specific cost of each tool will be factored into the feasibility of the project and will be discussed in the feasibility study. The EA uses general cost estimates to determine whether the size and magnitude of the project alternatives are manageable for the local sponsor and the Corps. The specific costs of the possible tool combinations will be set forth in the feasibility study. The EA sets forth sufficient information to allow the reader to evaluate the environmental effects of the tools and combinations thereof.

The local sponsor has explored other funding sources.

Comment 3: Thank you for your comment. The Corps recognizes the complicated and difficult task of monitoring. An in-depth plan designed to document the success or failure of various aspects of the project is currently under development and is being coordinated with appropriate resource agencies. The plan would be finalized prior to implementation of restoration measures. Monitoring would be conducted throughout the construction process. Adjustments and modifications would be made to ensure reasonable and adequate methods are used as the project progresses toward completion. Post-project monitoring is included in the plan.

Monitoring procedures have been slightly modified from those identified in the EA. Post-construction monitoring for at least a 10-year period was requested by one commenting agency in response to public review of the EA. Monitoring costs and duration were subsequently discussed between the local sponsor, the Walla Walla District and the Corps' Northwest Division. The issue was resolved through the decision for the Corps and local sponsor to share the cost of monitoring for a five-year period following completion of construction at each site. Phased construction would necessitate four years to complete all four sites. Post-construction monitoring would cumulatively encompass 8 years beginning with the monitoring of the first completed site and ending with the fifth year of monitoring for the fourth constructed site. The cost of pre-construction monitoring and monitoring during construction, as well as post-construction monitoring for the first five years to determine the need for

Response to April 8, 1999 letter from United States Environmental Protection Agency (Cont'd)

maintenance, would also be shared between the Corps and local sponsor. The local sponsor's share of five-year monitoring costs would be factored into the cost-share agreement. After the initial five years of monitoring at each site, the local sponsor would continue monitoring and bear all costs of monitoring necessary to determine the need for maintenance to structures. This maintenance monitoring would be conducted by the local sponsor for the life of the project. Actual maintenance measures would be later identified during the planning, engineering and design phase of the restoration project.

Comment 4: The reference in the EA on page 4-3 applies to Areas 1 and 4 only. The discussion indicates that gravel transport and deposition has only decreased. Transport and deposition of gravel has not ceased in Areas 1 and 4. We concur that aggradation (deposition) of gravel, though slowed from previous rates, appears to be continuing in Areas 1 and 4.

Discussion of Areas 9 and 10 are contained on page 4-2. The Corps' analysis indicates the leveed portions of Areas 9 and 10 have experienced a net loss of bed material (degrading). The rate of degradation also appears to be decreasing over time. Because materials continue to be deposited downstream at Areas 1 and 4, maintenance of channel stabilization pools, secondary channels, and off-channel pools would eventually be necessary. In Areas 9 and 10, even though a net loss of bed material is occurring, gravel is still being transported through these areas and being relocated and deposited locally within these areas. Maintenance of the channels and pools may continue to be necessary due to local deposition and the time required for some restoration measures (such as establishment of vegetation) to become fully effective.

As indicated on page 5-9, the quantity of sediment being transported downstream cannot be precisely calculated and will vary from year to year. Consequently, a channel stabilization pool may require several years to fill sufficiently to necessitate maintenance if it is located some distance from the main channel and if the channel doesn't move over to the pool location. However a single event could achieve the same result. The location of a pool with respect to the active channel is at least as important at the flood level. A variety of locations were selected for the pools in order to increase the probability that one or more pools would survive for an extended time. However, the Corps does not feel that additional analysis would yield data sufficiently reliable to predict the level of flow that may necessitate maintenance or to accurately predict the frequency with which such maintenance would be required.

Comment 5: See Response to March 29, 1999 letter from Jackson Hole Conservation Alliance, Comment 1. The Corps will communicate closely with the local sponsor to obtain available effectiveness, cost, and longevity data on the various tools.

Response to April 8, 1999 letter from United States Environmental Protection Agency (Cont'd)

Comment 6: See response to Comment 4.

Comment 7: Your comment concerning use of the terms "restoration" and "enhancement" is noted. The term "preserve" is used in paragraph 1.c. to represent measures to protect aquatic and terrestrial habitat from loss or degradation. "Enhance" is used to represent measures to promote reestablishment of lost aquatic and terrestrial habitat.

Comment 8: See response to April 6, 1999 letter from United States Department of the Interior, Bureau of Land Management, Comment 1.

Comment 9: Thank you for your comment. The following supplemental discussion is incorporated here as an addition to Appendix E, Clean Water Act, Section 404(b)(1) Evaluation, of the EA.

Three alternatives to restoring fish and wildlife habitat were evaluated in the EA. A 4th alternative, no action, was also evaluated. Each of Alternatives 1, 2, and 3 were capable of achieving the basic purpose of the project. However, Alternatives 1 and 2 were determined to not be practicable due to cost and logistics of obtaining access to areas outside of the levees. Costs associated with Alternative 3 were found to be practicable. Logistical issues associated with access were resolved for Alternative 3 by the restriction of work to areas between the levees only. The no action alternative would not achieve the project purpose.

Based on this, the Corps determined Alternative 3 to be the only practicable alternative that satisfies the project purpose. The Corps also feels there are no other practical alternatives having less adverse impacts that would better achieve the basic purpose of the project.

In order to satisfy the basic project purpose, discharges of dredged and fill material must occur in waters of the United States. Areas other than the four selected, and that are between the levees and suitable for restoration, are likely available. However, implementation of restoration measures at other locations between the levees would merely result in a similar level of effects and cost without tangible additional benefit. Based on this, no practicable alternative sites are considered available.

By letter dated April 9, 1999, the State of Wyoming, Department of Environmental Quality certified the project under Section 401 of the Clean Water Act.

Based on the above and the Corps' evaluation of the project under Subparts C through G of the Guidelines (See Appendix E to the EA), the project would comply with Part 230, Section 404(b)(1), Guidelines for Specification of Disposal Sites for Dredged or Fill Material.

WYOMING
GAME AND FISH DEPARTMENT

Jim Geringer, Governor | John Baughman, Director

"Conserving Wildlife —Serving People"

April 9, 1999

WER 5225
U.S. Corps of Engineers
Walla Walla District
Environmental Assessment
Section 404(b)(1) Evaluation and Draft Finding of
No Significant Impact Project
Public Notice Number CENWW-PD-EC 99-01
Environmental Restoration Project
Jackson Hole Flood Control Project
Teton County

Walla Walla District, Corps of Engineers
Environmental Compliance Branch
ATTN: James S. Smith
201 N. 3rd Avenue
Walla Walla, Washington 99362-1876

Dear Mr. Smith:

The staff of the Wyoming Game and Fish Department has reviewed the Environmental Assessment, Section 404(b)(1) Evaluation and Draft Finding of No Significant Impact for the proposed Jackson Hole, Wyoming, Environmental Restoration Project. We offer the following comments for your consideration.

Terrestrial Considerations:

1 According to the Environmental Assessment (page 1), construction of levees have reduced the available floodplain, resulting in increased water velocities, unstable channel configurations, elimination of natural channel braiding, and erosion of islands and associated vegetation. Loss of terrestrial habitat (shrub-willow and cottonwood-riparian areas) that provides habitat for a number of passerine birds, raptors, and large and small mammals has also been documented.

2 The Environmental Assessment documents serious declines in both the quantity and quality of riparian habitat. Riparian habitat within the levees has decreased from 2,761 acres in 1956 to 1,176 acres in 1986, cottonwood regeneration has declined, and cottonwood-spruce habitat has replaced riparian habitat behind the levees (page 3-1). Although not mentioned in the

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Environmental Assessment, continued construction of human residences behind the levees within the flood plain has also resulted in a loss of riparian habitat and displacement of wildlife.

The Snake River corridor and associated riparian areas contain some of the most valuable wildlife habitat for a variety of resident and migratory species. Nesting bald eagles along this corridor have contributed substantially to recovery of this species within the Greater Yellowstone
3 Ecosystem. The river corridor provides nesting, roosting, and foraging habitat for a variety of bird species; cover, foraging and wintering habitat for large and small mammals; and habitat for amphibians and reptiles. It also provides an extremely important movement corridor for wildlife within the Jackson Hole area.

The Environmental Assessment includes a brief description of the wildlife species found within the project area and also includes, as Appendices, the Biological Assessment (Appendix A) and the U.S. Fish and Wildlife Service Coordination Act Report (Appendix B). We have reviewed these documents. Following are comments and suggestions:

4 1. The Environmental Assessment monitoring plan calls for post-project monitoring only (page 5-8). We suggest, since the project will not be initiated until 2001, that 1-2 years of pre-project monitoring be undertaken in the four project areas, especially during the actual time periods of the year when the proposed project work will take place. Collection of baseline data on wildlife use of these areas would provide information for development of specific mitigation measures to avoid disturbance during project implementation, and also would provide baseline data for comparison with post-project monitoring. Data on current bald eagle foraging and roosting locations, and on resident amphibian populations, would be especially useful.

5 2. Post-project monitoring should continue for at least 10 years, and should include detailed documentation of vegetation changes and surveys of game and non-game species.

6 3. The data included in the Environmental Assessment on bald eagle nest locations does not include locations for all known alternate nests (page 6-28). We encourage the Corps to coordinate closely with the Department's Nongame Biologist in Jackson to obtain locations of alternate nest sites, as well as any new nest locations during project implementation. We suggest the Corps also review and implement management guidelines from the following report: *Bald Eagles in the Greater Yellowstone Ecosystem* (WGFD, Dec. 1992).

7 4. Of the four project areas, three (Areas 1, 4, and 10) fall within the primary management zone (Zone I, 400 meters) of nesting pairs of bald eagles. Management guidelines recommend that within this zone, habitat alternations should only occur for the maintenance or enhancement of nesting habitat (WGFD, Dec. 1992: Table 57). We are especially concerned about Area 10, as it has recently experienced increased disturbance due to home construction in the immediate area. We suggest that project work not take place until after the young have

dispersed from this territory (early to mid September). We also recommend that bald eagle activity be monitored prior to, during, and after project implementation at all territories.

8 5. The Environmental Assessment mentions two species of owls that occur occasionally in the project areas (great gray and flammulated) but does not mention other species that likely nest within the Snake River corridor. These include great horned owl, long-eared owl, pygmy owl, and saw-whet owl. These should be added to the list of species. The statement:
9 "Raptors would avoid construction activities until they habituate to it." (page 6-26) should be deleted, as it is not clear that such habituation would in fact take place.

10 6. We recommend avoiding construction activities in ungulate migration corridors during spring (April-May) and fall (Nov-Dec) migration periods. If work needs to be completed during such times, it should be closely coordinated with Regional Department personnel to develop site-specific mitigation measures.

11 7. Trumpeter swans winter within the project areas, and have been observed this winter in areas 9 and 10. Construction of some reclamation ponds to enhance winter foraging is encouraged. We recommend the Corps coordinate with the Department for input on pond construction and vegetation that would benefit this species.

12 8. Data on amphibians (Environmental Assessment, page 6-27) include some incorrectly spelled scientific names (*Rana* not *Ranu*) and incomplete distribution information. In the Jackson area, spotted frogs and boreal chorus frogs are considered common, the boreal toad is likely declining in abundance, and the northern leopard frog is extremely rare and maybe extinct (*Amphibians and Reptiles of Yellowstone and Grand Teton Parks*, Koch and Peterson, 1995). We suggest that surveys for amphibians be conducted by experienced field biologists in all project areas, and that breeding habitat, especially for boreal toads, be identified and protected. Tadpoles could still be present in pools in mid-August when construction activities take place. Concentrations of tadpoles or metamorphs should be protected or moved from construction areas.

13 9. We are concerned that annual maintenance may be needed for restoration features, and this may result in repeated and on-going disturbance in the project areas. We encourage the Corps to carefully evaluate proposed restoration techniques in the demonstration area (Area 9) prior to implementation in other areas to ensure that repeated restoration does not result in long-term disturbance to resident wildlife populations. This disturbance may outweigh proposed benefits. If it becomes apparent that stabilization and regeneration projects in riparian areas are not being achieved, the project design should be modified.

14 10. We concur with the U.S. Fish and Wildlife Service (in the Coordination Act Report) that, although this project may assist in the restoration of limited fish and wildlife habitat, a

system-wide solution is still necessary to protect important fish and wildlife resources negatively impacted by levees along the Snake River.

Aquatic Considerations:

We support the concept of the proposed restoration project, but doubt if the objectives of the project are actually attainable given the constraints of having to work within the existing (and expanding) levee system. With this in mind, we offer the following comments:

2.0 Project Purpose and Need -- This section seems to present the argument that the proposed project will restore all habitats lost due to the construction of the Jackson Hole Flood Control Project. At most, any habitat created by the proposed restoration project will be a small
15 percentage of habitats lost over the last several decades due to flood control activities. The only way restore any significant percentage of lost habitats would be by removing levees.

4.0 Four Alternatives Considered -- We believe another alternative, or an add-on to the
16 described alternatives should be included. This would be for the Corps of Engineers to provide funding to maintain spawning habitat in Snake River tributaries.

5.1.5 Off-Channel Pools -- Off-channel pools will not provide any spawning habitat. Also, as mentioned in previous correspondence, we caution removal of gravels in some side channels. If proper design and location are not considered, some newly created resting pools could ultimately be prime areas for fish entrapment during periods of low flows. All side channels where gravel
17 is to be excavated need to maintain enough surface flow throughout the flow regime to allow fish utilizing these pools to move in and out of these areas. In addition, as documented by our sampling this past winter, there exists the potential for dissolved oxygen conditions to drop to lethal levels for salmonids in these pools if there is not sufficient flows.

6.2 Aquatic Environment

6.2.1.1 Cutthroat Trout (Habitat Quantity and Quality Assessment) -- How the assessment of habitat units (with and without project) was determined is unclear. Though
18 the relationships shown in Figure 6-1 may be accurate for a given site, the benefit of this project to the Snake River system as a whole will be negligible and should be noted. Also, unless there is a high level of maintenance on these created habitats, they too will degrade over time.

19 We disagree with the statement indicating this project will lead to "healthier" cutthroat. Although, more fish may overwinter, there is no indication any fish will be "healthier".

20 6.2.1.2 Other Game Fish Species -- *Salvelinus* is misspelled. *Namaycush* is misspelled.
21 Delete arctic grayling from this list. There is only one documented occurrence of
22

grayling in the Snake River, and this individual probably drifted down from Toppings Lake.

<u>6.3.2.5 Reptiles and Amphibians</u> -- In regards to the boreal toad, it should be noted that there are two recognized populations of boreal toads in Wyoming. The project area is within the distribution zone for the northern population. The southern population inhabits the Snowy
23 Range and Sierra Madre Mountains in south-central Wyoming. The southern population is considered a "candidate" species under the Endangered Species Act, and has been the focus of a recently signed habitat conservation plan.

<u>6.3.2.6 Threatened and Endangered Species</u> -- The Yellowstone cutthroat trout has been petitioned to the U.S. Fish and Wildlife Service for listing under the Endangered Species Act. Under this petition, the Snake River cutthroat trout is addressed as and considered to be a form of
24 Yellowstone cutthroat trout. Although the Wyoming Game and Fish Department recognizes the Yellowstone and Snake River cutthroat subspecies to be distinct and separate, this issue should be addressed in this document.

<u>6.7 Socioeconomics (page 6-38)</u> -- The document states that over the 50-year project period the average annual fish numbers will be maintained. However, if the spring tributary systems are not
25 maintained, the proposed project will provide no long-term benefit to Snake River cutthroat trout populations. The position of the Wyoming Game and Fish Department is that the key to maintaining the Snake River fishery is in maintaining/enhancing the quality and access to the spawning areas in the spring creeks.

26 <u>6.8 Recreation (page 6-38)</u> -- We disagree with the statement that the South Park area receives limited public recreational use. Please contact Steve Kilpatrick in our Jackson Office to obtain accurate information.

We appreciate the opportunity to comment on this project and encourage the Corps to coordinate closely with our agency throughout the life of this project.

Sincerely,

Bill Wichers

BILL WICHERS
DEPUTY DIRECTOR

BW:TC:as
cc: Bill DiRienzo-DEQ/WQD
Dave Ruiter-EPA
USFWS

Response to April 9, 1999 letter from Wyoming Game and Fish Department

Comment 1: Your comment is noted and incorporated here as an addition to the EA.

Comment 2: Your comment is noted and incorporated here as an addition to the EA.

Comment 3: Your comment is noted and incorporated here as an addition to the EA.

Comment 4: We agree that long-term pre-project monitoring would provide a better picture of the project's effects upon wildlife populations in the four areas. However, 1-2 years of pre-project monitoring is currently not feasible under the existing budget and schedule. Given this limitation and the uncertainty of when construction may occur in each area, the Corps feels the most prudent approach is to monitor for impact avoidance. This type of monitoring would be performed during the last 30-day period prior to the start of construction and carry through the construction itself. Short-term pre-project monitoring is included in a monitoring plan currently being developed and distributed for coordination with multiple resource agencies, including Wyoming Game and Fish Department.

Comment 5: See response to April 8, 1999 letter from United States Environmental Projection Agency, Comment 3. Monitoring would include documentation of wildlife habitat and vegetation changes. See response to March 29, 1999 letter from Jackson Hole Conservation Alliance, Comment 1.

Comment 6: Pre-construction monitoring and monitoring during construction would include coordination to identify locations of alternate next sites as well as new nest locations.

Comment 7: Thank you for your comment. The BA, Appendix A to the EA, discusses monitoring of bald eagle activity prior to and during construction. Paragraph 5.2 of the EA discusses post-project monitoring. Bald eagle activity would be monitored during pre-construction, construction, and post-construction. See response to Comment 5. The Corps intends to work closely with Wyoming Game and Fish Department during pre-construction and construction to minimize impacts upon significant wildlife resources.

Comment 8: Thank you for your comment. The list in the EA identified sensitive species found in the area and included only some of the locally common species. The great horned owl is identified in paragraph 6.3.2.4.2 of the EA. The remaining species mentioned in your comment, long-eared owl, pygmy owl, and saw-whet owl are noted and incorporated as an addition to the EA.

Response to April 9, 1999 letter from Wyoming Game and Fish Department (Cont'd)

Comment 9: Thank you for your comment. The great-horned owl has been documented to habituate to human disturbance, however habituation may or may not occur. Habituation likely would not occur if construction is short-lived. The 1st sentence of the 7th paragraph on page 6-26 of the EA is replaced with the following sentence and is incorporated as a revision of the EA: "Raptors would likely avoid construction areas until construction disturbances have ended or until they habituate to the disturbance".

Comment 10: Thank you for your comment. Paragraph 6.3.2.2 of the EA discusses timing restrictions relating to ungulate migration and coordination with Wyoming Game and Fish Department personnel.

Comment 11: Thank you for your comment. Impacts to trumpeter swans are discussed in paragraph 6.3.2.4 of the EA, as well as in the CAR, Appendix B to the EA. The Corps recognizes the variety of fish and wildlife habitat that exists in the area, including the importance of foraging habitat for trumpeter swans. Several restoration tools have been identified in the EA to address both aquatic and terrestrial habitat. Reclamation ponds to specifically enhance foraging habitat for trumpeter swans was not identified as a recommended tool during the numerous project planning meetings and therefore, is not included among the planned restoration tools. The Corps would consider investigation of reclamation ponds as a restoration tool on any future restoration cost-share studies.

Comment 12: Thank you for your comment.

Comment 13: See Response to March 29, 1999 letter from Jackson Hole Conservation Alliance, Comment 1. Additionally, the Corps intends to make modifications to the restoration tools as new information is gathered through the demonstration project and throughout construction at the restoration sites. Modifications would be intended to maximize habitat protection and establishment, and improve structure function and integrity, thereby reducing the potential need for annual maintenance.

Comment 14: The Corps acknowledges that this project would not restore all fish and wildlife habitat that has been destroyed or degraded. The Corps is hopeful that future cost-share agreements with a local sponsor may be entered to continue the protection and restoration efforts.

Comment 15: Thank you for your comment.

Comment 16: See response to April 6, 1999 letter from United States Department of the Interior, Bureau of Land Management, Comment 1.

Response to April 9, 1999 letter from Wyoming Game and Fish Department (Cont'd)

Comment 17: Your comment on spawning habitat is noted. The words "spawning and" are deleted from the 1st sentence of paragraph 5.1.5 of the EA. This change is incorporated as a revision of the EA. In addition, off-channel pools would be constructed with these considerations in mind. Post-construction monitoring would be conducted to ensure adequate flows.

Comment 18: Figure 6-1 represents a combined estimate of fish habitat unit projections for the four restoration areas and, therefore, is not intended to represent any single site. The Corps recognizes that each site is different and that the quantity and quality of fish habitat that may be restored will vary from site to site. The Corps also recognizes there are numerous areas along the Snake River that could benefit from restoration efforts and that any benefits derived from restoration in the four areas would be a small portion of any overall potential benefits. Monitoring would be used to assess the level of maintenance necessary for the various tools.

Comment 19: Healthier is used to refer to the possibility that increased resting areas could lead to a lower density of fish per resting area. A lower density of fish per resting area can result in less competition or stress, which could lead to larger or healthier fish after the critical winter period.

Comment 20: Your comment is noted and incorporated here as a revision of the EA.

Comment 21: Your comment is noted and incorporated here as a revision of the EA.

Comment 22: Your comment is noted and incorporated here as a revision of the EA.

Comment 23: Thank you for clarification on this issue. Your comment is noted and incorporated here as an addition to the EA.

Comment 24: Effects of the project upon Snake River cutthroat trout are included in the EA. Should Snake River cutthroat trout be formally listed under ESA, the Biological Assessment would be updated to reflect the listing and any required consultation would be conducted.

Comment 25: Thank you for your comment. The Corps recognizes the importance of access to quality spawning areas in the spring creeks and has attempted in the past to implement restoration measures outside of the levees. See response to April 6, 1999 letter from United States Department of the Interior, Bureau of Land Management, Comment 1. The Corps would gladly work with a local sponsor under a cost-share agreement to investigate the feasibility of implementing measures to improve access to spawning areas in the spring creeks. Additionally, the Corps would require the local sponsor to acquire conservation easements to protect improvements to spawning areas.

Response to April 9, 1999 letter from Wyoming Game and Fish Department (Cont'd)

Comment 26: Thank you for your comment and recommendation. The Corps contacted Mr. Steve Kilpatrick of Wyoming Game and Fish Department in Jackson, Wyoming. Mr. Kilpatrick indicated that recent completion of a paved bike path that connects to the South Park Habitat Management Area road system, which connects to the levee system, has resulted in recent increases in public recreational use. The paved path is open to biking, hiking and horseback riding. He estimated the levees in the South Park area receive moderate use from about May 1 through mid-July and heavy use from mid-July till September. Presently, hiking/walking is the most prominent use. Biking is expected to increase substantially as more people become aware of the inter-connecting path, roadways and levees. This new information is incorporated as an addition to the EA.

The State
of Wyoming

Department of Environmental Quality

Jim Geringer, Governor

Herschler Building • 122 West 25th Street • Cheyenne, Wyoming 82002

ADMIN/OUTREACH	ABANDONED MINES	AIR QUALITY	INDUSTRIAL SITING	LAND QUALITY	SOLID & HAZ. WASTE	WATER QUALITY
307-777-7758	307-777-6145	307-777-7391	307-777-7369	307-777-7756	307-777-7752	307-777-7781
FAX 777-3610	FAX 777-6462	FAX 777-5616	FAX 777-6937	FAX 777-5864	FAX 777-5973	FAX 777-5973

April 9, 1999

James Smith
Walla Walla District Corps of Engineers
Environmental Compliance Branch
201 N. 3rd Avenue
Walla Walla, WA 99362-1876

RE: **Certification of pending Environmental Restoration Project on the Snake River, located in various adjacent sections in T40N, R117W and T41N, R117W Teton County**

Dear Mr. Smith:

According to the provisions of the state certification program for activities requiring dredge and fill permits from the U.S. Army Corps of Engineers, this office has reviewed the above said application and offers the following comments regarding the proposed action:

1 As you know, the Snake River is listed as having two separate classifications as a surface water of the State. The portion of the river upstream of the Wyoming Highway 22 bridge is classified as a class 1 water, the remaining downstream portion is a class 2 water. Class 1 waters are those surface waters in which no further water quality degradation by point source discharges, other than from dams, will be allowed. Class 2 waters are those waters presently supporting game fish; or have the potential to support game fish; or include nursery areas or food areas for game fish.

2 Class 1 and class 2 waters have essentially the same standards applied to them to protect aquatic habitat. The discharge of solids must not be present in quantities that could result in degradation to the existing aquatic habitat. Additionally, turbidity created from the discharge of solids must not result in an increase greater than 10 NTU's above upstream levels. The environmental assessment (EA) completed for this project addresses this concern and proposes a monitoring program to insure impacts do not exceed state standards. The DEQ has no additional conditions to place on this project as long as activities are carried out as described in the EA.

The Wyoming Department of Environmental Quality certifies this project is acceptable providing construction is accomplished according to the above stated recommendations, and you take
3 reasonable care to ensure that all disturbed areas are protected from erosion. The Department also reserves the right to amend, modify, suspend or revoke this certification or any of its terms or conditions as may be appropriate or necessary to protect water quality and associated beneficial uses.

Please be aware that this letter only constitutes state certification of this project as required by Section 401 of the Federal Clean Water Act. This letter does not exempt the Corps from any other federal, state or local laws or regulations, nor does it provide exemption from legal action by private citizens for damage to property that the activity may cause.

Sincerely,

Dennis Hemmer
Director
Department of Environmental Quality

DH/GB/CA/mad 90778.ltr

cc: Tom Collins, Wyoming Game and Fish, Cheyenne
Dave Ruiter, EPA, Denver (8 EPR-EP)
Mike Long, US FWS, Cheyenne

Response to April 9, 1999 letter from the State of Wyoming, Department of Environmental Quality

Comment 1: Thank you for your comment.

Comment 2: Thank you for your comment.

Comment 3: Thank you for your comment and review of the project under the Guidelines established under Section 404(b)(1) of the Clean Water Act.

JACKSON HOLE, WYOMING, ENVIRONMENTAL
RESTORATION PROJECT
ENVIRONMENTAL ASSESSMENT

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GLOSSARY OF TERMS

Bank Barb: Rigid, riprap structure projecting into the current from the bankline. Its function is to deflect the current away from the bank, trap sand, provide flow diversity, and resting places for fish and other aquatic organisms. Dimensions vary, and the typical length averages 26 feet.

Channel Capacity Excavation: The excavation of riverbed cobble and gravel to increase flow capacity of the channel. Channel capacity excavations compensate for decreases in channel capacity resulting from deposition of bedload material and sediments and constricts flow to reduce erosion of point bars and islands.

Channel Stabilization Pool: See definition of sediment trap.

Eco Fence: A structure designed to trap and retain floating woody debris. Two types are referenced in the Environmental Assessment: Rock Eco Fence and Piling Eco Fence. The fences are employed to reduce erosion and to promote deposition. Flow velocities are reduced immediately downstream of fences, causing deposition of sediments. Deposited sediments facilitate bar/island formation and provide opportunity for establishment of vegetation. Fences also prevent erosion of existing bars/islands located immediately downstream.

Hack Sites: Acclimation area for raptors being reintroduced to the region.

Kicker: Same as a bank barb, except the kicker has a gravel and cobble core and a typical length averages 56 feet.

Off-Channel Pool: A pool constructed adjacent to the main channel. This serves as overwintering and rearing habitat for juvenile Snake River fine-spotted cutthroat trout and is used as a resting area by waterfowl.

Ordinary High Water Mark (OHWM): This is the general average elevation of annual ordinary high flows for a particular waterway. A line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank; shelving; changes in the character of soil; destruction of terrestrial vegetation; the presence of litter and debris; or other appropriate physical characteristics

Palustrine Scrub-Shrub (PSS): A class of wetland dominated by woody vegetation less than 20 feet tall. Includes true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions. It is a successional stage of vegetation often leading to forested wetlands on river floodplains as islands.

Palustrine Forest (PF): A class of wetland characterized by woody vegetation that is 20 feet tall or taller.

GLOSSARY OF TERMS (Continued)

Piling Eco Fence: An eco fence constructed of driven steel piles with interconnecting cables. See definition of eco fence.

Rock Eco Fence: An eco fence constructed of riprap. See definition of eco fence.

Rock Grade Control: A layer of riprap forming a weir to prevent erosion or downcutting of channel.

Root Wad Log: A tree trunk with a root wad attached. It is anchored in cobble to provide in-stream woody debris and promote sediment deposition.

Secondary Channel: A channel constructed adjacent to the main channel to transport flow to and from off-channel pools.

Sediment Trap: The excavation of riverbed cobble and gravel to create area of low-velocity flow so that bedload material drops out of the flow and is not transported further downstream.

Side Pool: See definition of off-channel pool.

Spur Dike: Spur dike usually refers to a single structure. However, as used in this environmental assessment the term represents a series or grouping of multiple bank barbs or kickers (as shown on the plates contained within this document).

Staging Area: Area for storage and dispensing of equipment fuels and lubricants. Also an area for equipment storage overnight or during nonuse.

Supply Channel: See definition of secondary channel.

ACRONYMS AND ABBREVIATIONS

BA	Biological Assessment
BLM	Bureau of Land Management
CAR	Coordination Act Report
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	Cubic feet per second
Corps	U.S. Army Corps of Engineers
DEQ	Department of Environmental Quality
EIS	Environmental Impact Statement
FIS	Flood Insurance Study
FONSI	Finding of No Significant Impact
HEC	Hydrological Emergency Center
HEP	Habitat Evaluation Procedure
HSI	Habitat Suitability Index
kaf	1,000 acre-feet
NEPA	National Environmental Policy Act
OHWM	Ordinary High Water Mark
PF	Palustrine Forest
PSS	Palustrine Scrub-Shrub
SHPO	State Historic Preservation Office
USGS	U.S. Geological Service
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
WGFD	Wyoming Game and Fish Department
WYNDD	Wyoming Natural Diversity Database

JACKSON HOLE, WYOMING, ENVIRONMENTAL RESTORATION PROJECT ENVIRONMENTAL ASSESSMENT

1.0 INTRODUCTION

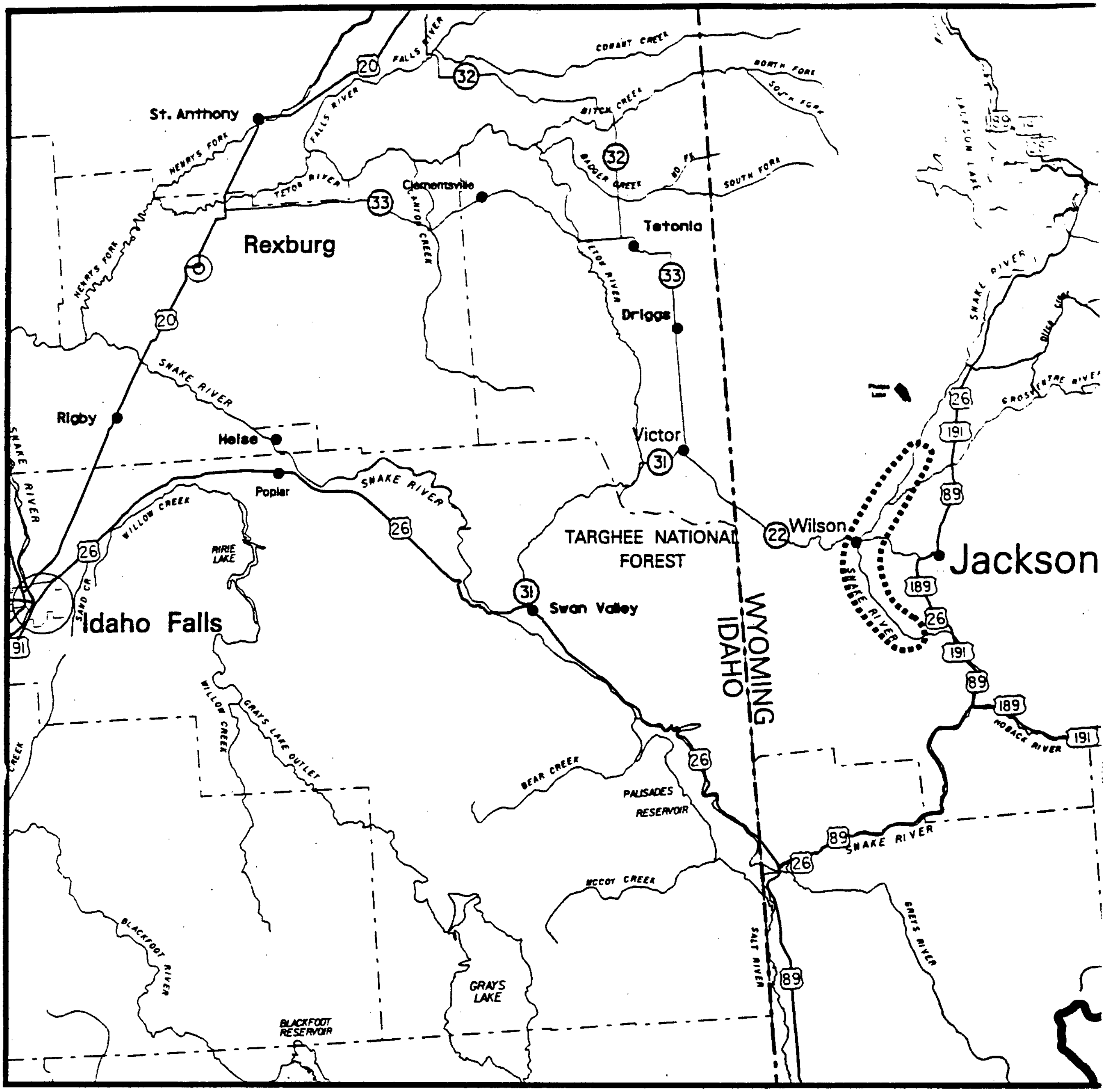
This environmental assessment (EA) considers the effects of restoring wetland and riparian habitats in the Snake River, between Grand Teton National Park and South Park Elk Feed Grounds near Jackson, Wyoming (figure 1-1 and plate 1). The proposed Jackson Hole, Wyoming, Environmental Restoration Project would involve channel stabilization measures to protect and increase fisheries habitat, island protection measures to preserve riparian island values, island environmental restoration measures to restore lost riparian values, and stream structure alteration to create fish habitat. The environmental restoration project is proposed in response to environmental resource impacts resulting from levees constructed under the Jackson Hole Flood Control Project.

The Jackson Hole Flood Control Project was authorized in the Flood Control Act of 1950, and provided flood protection by levees and revetment along the Snake River in Jackson Hole, Wyoming. The Jackson Hole Flood Control Project was completed in the fall of 1964, and the sponsor was Teton County. Additional levees were added to the system by other agencies and by "emergency flood fight" operations of the U.S. Army Corps of Engineers (Corps) and Teton County through 1997.

Authority to operate and maintain the Jackson Hole Flood Control Project was granted by Section 840 of the Water Resources Development Act of 1986 (Public Law 99-662) to the Secretary of the Army, including additions and modifications constructed by non-Federal sponsors, provided that the local sponsor provides the first $35,000 in any one year (adjusted for inflation). The Corps signed a Local Cooperative Agreement with Teton County in September 1990, after completion of a Decision Document and Environmental Impact Statement (EIS). The Corps assumed operation and maintenance responsibility for the levee system on the Snake and Gros Ventre Rivers in Jackson Hole, Wyoming.

The Jackson Hole, River and Wetland Restoration Study, Wyoming, was authorized by the U.S. Senate Committee on Environment and Public Works in a Study Resolution of June 12, 1990. The scope of the study was to determine the feasibility of providing environmental restoration to wetland and riparian habitats located between the flood control levees. Teton County, the local sponsor for the proposed environmental restoration project by the Corps, would provide funds in accordance with cost sharing requirements specified in Public Law 99-662, as amended.

As required by the National Environmental Policy Act (NEPA) of 1969 and subsequent implementing regulations promulgated by the Council on Environmental Quality (CEQ), this EA was prepared to determine whether the proposed environmental restoration project constitutes a "...major Federal action significantly affecting the quality of the human environment..." and whether an EIS is required.



NOT TO SCALE

PROJECT LOCATION

Geographic Information Systems
Corps of Engineers
Walla Walla District

Walla Walla District

Jackson Hole, Wyoming
Environmental Restoration Project

VICINITY MAP

1-3

PLOTTED 03-MAR-1998 13:34

Figure

2.0 PROJECT PURPOSE AND NEED

The purpose of this environmental restoration project is to restore fish and wildlife habitat that was lost as a result of construction, operation, and maintenance of levees constructed under the Jackson Hole Flood Control Project, including levees constructed by non-Federal interests. The project is located in the Snake River, near Jackson, Teton County, Wyoming.

While the levees have contributed significantly toward reducing flood damage potential along the river corridor, over time the levees have significantly changed the physical character of the river system and contributed to the loss of environmental resources. This environmental restoration project is needed to prevent further degradation and destruction of environmental resources within the study area and to facilitate recovery of lost aquatic and terrestrial habitat. The project has high potential for restoring fish and wildlife habitat through enhancement and restoration of the aquatic and terrestrial environment, including wetland and riparian vegetation and in-stream fisheries habitat.

3.0 EXISTING CONDITION

Flow velocities in both the main channels and the secondary channels tend to be high, due to the general steepness of the valley. Due to the high transport of bedload, the channel bed complex is constantly changing. During high flows. avulsion of the main channel into side channels is common. When the flow erodes a gravel bar or the main channel becomes clogged with debris, the flow can shift direction suddenly and unpredictably. However, construction of the Federal and non-Federal levees along the Snake River blocked the lateral spread of the river and reduced the width of the floodplain and the degree of randomness of the braided system. This limited the ability of the channel to migrate and restricted avulsion activity to the area between the levees, concentrating flows in the existing main channels and increasing the frequency of attack on islands and vegetation between the levees. The flow concentration and increased frequency of attack is preventing the natural recovery of islands and vegetation. Bedload materials, brought into suspension by the turbulent flow, are more likely to be carried through the system rather than being carried laterally into the slower secondary channels where they could be redeposited over a wider area of the floodplain.

Flood damages include loss of land due to bank erosion, loss of shrub-willow and mature cottonwoods, and damage to levees due to erosion or undercutting.

The quantity of riparian habitat, within the levees, has decreased from 2,761 acres in 1956 to 1,176 acres in 1986. The quality of the remaining riparian habitat has also declined (Corps 1998). The area of cottonwood forest behind the levees remained approximately constant between 1956 and 1986, but the quality of this habitat has been reduced. The percent of mature cottonwoods has increased behind the levees, indicating that cottonwood regeneration has declined. There was a 149 percent increase of cottonwood-spruce habitat from 1956 to 1986 behind the levees, indicating a loss of riparian habitat. The loss has been compounded by the side channels and spring creek habitats being cutoff from the river by the levees (Corps 1998).

The Snake River, in part of the area of the proposed action, is designated a Class 1 trout fishery by the Wyoming Game and Fish Department (WGFD). This designation signifies the river is of national importance as a trout fishery. This fishery is composed primarily of Snake River fine-spotted cutthroat trout (cutthroat trout) (*Oncorhynchus chlarki* spp). Numerous other game fish and non-game fish are present [U.S. Fish and Wildlife Service (USFWS) 1990]. Spawning habitat for the cutthroat trout is considered one of the major factors limiting population for this species in the upper Snake River drainage. Little or no spawning habitat exists in the main river because high flows, particularly during spring runoff, produce large sediment bedloads and turbidity during the spawning period. Spawning habitat losses have occurred from human activities, including diversions for irrigation and levee construction (USFWS 1990).

A variety of wildlife species, which use the Snake River in the environmental restoration project area, are affected by declines in wetland and riparian vegetation. including shrub-willow and cottonwood. Bald eagles (listed threatened by the USFWS) actively nest in close proximity to the project area. Bald eagles commonly use the snags (woody debris) and large living trees along the river for nesting and roosting (Corps 1994). Peregrine falcons often forage within the project areas. This species is presently classified as endangered by the USFWS and as Native Species Status 3 by the State of Wyoming due to restricted habitat availability and declining populations. Resident and migratory waterfowl use the Snake River and its tributaries for spring and fall staging, breeding, nesting, brood rearing, and wintering habitat (USFWS 1990). A large variety of other wildlife species use the aquatic and terrestrial habitat in the project area including trumpeter swans, whooping cranes (listed as endangered by USFWS), moose, elk, mule deer, various fur bearers, and numerous small mammals.

4.0 FOUR ALTERNATIVES CONSIDERED

4.1 ALTERNATIVE 1—MULTIPLE AREA RESTORATION WITHIN 500-YEAR FLOODPLAIN

This alternative would involve studying and implementing a combination of environmental restoration measures at an unlimited number of areas throughout the entire 500-year floodplain of the Snake River from Moose to South Park Elk Feed Grounds, Wyoming, approximately 25 miles. Measures would be implemented, in a manner that would not reduce the base flood capacity, along non-leveed stretches, as well as leveed stretches, including areas between and outside of the levees.

The Corps identified a set of environmental restoration tools or measures best suited for the conditions occurring throughout the 500-year floodplain. These included: gravel removal; channel stabilization pools; secondary channels leading to and from off-channel pools; off-channel pools; spur dikes (bank barbs and kickers); eco fences (both rock and piling fences); anchored root wad logs; rock grade control structures; and head gates. Refer to paragraph 5.1 for a listing of the proposed tools. Spur dikes, eco fences, anchored root wad logs, and rock grade control structures would be designed to have multiple strengths based on the use of alternative materials. Material selection would be based on the level of strength determined appropriate to withstand 3 levels of major flow events: 15, 25, and 50 years. Table 4-1 provides a breakdown of the alternative materials that would provide different strengths for these structures. Rock gradations referenced in table 4-1 are based on minimum and maximum rock size for each gradation, ranging from the smallest for gradation 1 to the largest for gradation 4. When complete, the cost-benefit analysis being prepared (as part of the Feasibility Study for this environmental restoration project) will compare the cost of constructing tools of various strengths to the aquatic and terrestrial habitat benefits that may reasonably be expected to accrue for each level of tool strength. The results of the analysis would be used in selecting material strength or level of protection.

A plan for studying the feasibility of implementing this alternative was prepared and submitted to the local sponsor. The plan exceeded the practical acreage and the local sponsor rejected the plan due to cost, therefore, this alternative was eliminated from further consideration.

4.2 ALTERNATIVE 2—RESTORATION AT 12 AREAS WITHIN 500-YEAR FLOODPLAIN

This alternative is based on reduction of the "Alternative 1—Multiple Area Restoration Within 500-year Floodplain" to 12 specific areas. The same environmental restoration tools, as Alternative 1, would be implemented within these 12 areas, with the exception of head gates, which were eliminated from the range of tools due to expense. A plan for studying the feasibility of implementing this alternative, consistent with the environmental restoration project's purpose and

need, was prepared and submitted to the local sponsor. The cost of the study was significantly reduced, however, it was eliminated from further consideration because the magnitude and the acreage of this alternative was impractical at this time and the local sponsor rejected the plan.

4.3 ALTERNATIVE 3—RESTORATION AT FOUR AREAS WITHIN 500-YEAR FLOODPLAIN

This alternative is based on reducing "Alternative 2—Restoration at 12 areas within 500-Year Floodplain" to 4 specific areas (refer to section 5.0 for a description of areas) that provide the best opportunity for restoration of aquatic and terrestrial habitat. To determine the 4 most suitable sites, the 12 sites were evaluated on the basis of their institutional recognition (national laws and regulations specific to the area); public recognition (environmental and economic value); and technical recognition (importance of spring creeks, spawning habitat, and eagle nesting). Additional analysis included the potential for channel creation for fisheries restoration, riparian island preservation and restoration, fish habitat creation, and spring creek restoration. This multiple objective analysis (along with specific input from the scoping process, local input and considerations of property ownership, and cultural resources) served as the basis for selecting the four areas. Further discussion of evaluation criteria used in selecting the four sites may be found in the Jackson Hole, Wyoming, Environmental Restoration, Project Study Plan, July 1996. This alternative was determined to be financially feasible for the local sponsor and would still provide aquatic and terrestrial habitat benefits consistent with the environmental restoration project's purpose and need.

4.4 ALTERNATIVE 4—NO ACTION

If no environmental restoration measures are instituted, the main channel of the Snake River would continue to shift back and forth between the levees in a random manner. Based on current trends, much of the remaining mid-channel stands of mature trees would be washed away in Areas 9 and 10. Because the river does not occupy the entire area between the levees, there would be some recovery, particularly in the wider portions of the channel. Some damaged areas of the channel, over time, have recovered long enough to develop a 10- to 20-year growth. However, it does not appear that the river is stable enough to allow any significant areas to remain undisturbed long enough for a 50-year growth to occur. The leveed reach has experienced a net loss of bedload material. However, the rate of loss appears to be decreasing with time. Erosion and reworking of the channel bed gravel would continue in the future, but at a gradually decreasing rate. The continual reworking of the channel bed gravel would result in a progressive loss of fine material, which supports vegetation. Recovery of damaged areas would be slower and larger areas of the channel bed would remain relatively vegetation free.

Areas 1 and 4 are likely to retain a more natural, random distribution of vegetation than Areas 9 and 10 since there is more space for lateral channel movement.

Gravel transport and deposition in Areas 1 and 4 were probably the highest just after completion of the levees and has decreased (on the average) since then. For this reason, it is likely that most of the damage resulting from excess gravel inflow has already occurred. It is not likely that the gross area of denuded gravel beds would increase in these two areas. However, the continued inflow and deposition of gravel is likely to keep the channel unstable (particularly in Area 4 at the downstream end of the Federal Levee Project). The channel in this area is likely to continue shifting to one side or the other, attacking new undisturbed banklines on the margins of the meander belt, frequently damaging vegetation, and preventing the establishment of mature stands of cottonwood and willow. Based on these observed general trends, if no action is taken, the physical character of the river system would continue to experience similar changes. These changes would reasonably result in the progressive loss of portions of the remaining aquatic and terrestrial habitat and interfere with the development of mature stands of cottonwood and willow. Recovery of impacted areas would generally continue to be limited by the shifting, unstable nature of the channel. Overall, a general decrease in the amount of aquatic and terrestrial habitat would continue.

Table 4-1. Optional Structure Strengths for 15-, 25-, and 50-Year Major Flow Events.

Level of Protection	Piling Eco Fence	Rock Eco Fence	Bank Barb	Kicker	Anchored Root Wad Log	Rock Grade Control
15 years	6-inch pipe casing	No Alternative	Rock Gradation 1	No Alternative	1/4-inch cable	Rock Gradation 1
25 years	8-inch pipe casing	No Alternative	Rock Gradation 2	No Alternative	1/4-inch cable	Rock Gradation 2
50 years	10-inch pipe casing	No Alternative	Rock Gradation 3	No Alternative	5/16-inch cable	Rock Gradation 3
50 years	No Alternative	Rock Gradation 4	No Alternative	Rock Gradation 4	5/16-inch cable	Rock Gradation 4

5.0 PREFERRED ALTERNATIVE

"Alternative 3-Restoration at Four Areas Within the 500-Year Floodplain" was selected as the preferred alternative. The four selected sites in Teton County, Wyoming, are identified as Areas 1, 4, 9, and 10, as depicted on plates 2, 3, 4, and 5, respectively. Area 1 is located in sections 13, 14, 23, and 24, Township 40 N., Range 117 W.; Area 4 is located in sections 2, 3, 10, and 11, Township 40 N., Range 117 W.; Area 9 is located in sections 13, and 24, Township 41 N., Range 117 W.; and Area 10 is located in sections 5, 6, and 7, Township 41 N., Range 117 W., Teton County, Wyoming.

5.1 DESCRIPTION OF THE PREFERRED ALTERNATIVE

The environmental restoration project would involve gravel removal and construction of channel stabilization pools; secondary channels leading to and from off-channel pools; off-channel pools; spur dikes (bank barbs and kickers); eco fences (both rock and piling fences); anchored root wad logs; and rock grade control structures. (For detailed tool descriptions, refer to paragraphs 5.1.1 to 5.1.9.) Head gates were eliminated as a restoration tool due to expense. The proposed tools would be used in various combinations within each of the four areas.

The environmental restoration measures were carefully sited and hydraulically analyzed with provision for the effects of structures and projected vegetation growth to assure that they would have no adverse impact on the flood control functions of adjacent levee projects. In fact, the environmental restoration measures were designed to stabilize the channel in areas where it approaches the levee, and to shift the channel away from the levees or eroding bank in other areas. Stabilizing the channel and shifting the channel away from the levees should reduce the potential for the river to affect the levees and potentially result in reduced maintenance and associated costs. Typical examples are in Areas 1 and 10 where eco fence groups were strategically placed in a manner as to restore a cushion of riparian vegetation between the main channel and the adjacent levees or eroding banklines.

Temporary water diversions or berms would be necessary at some locations to de-water gravel removal sites. Water diversion materials would be excavated from dry adjacent cobble, gravel, and sand deposits. The berms would be used to alternately de-water braided channels (to allow the channel capacity excavations to occur in non-flowing waters) and portions of channels to allow work (to occur outside of the flowing water). Following completion of work in the area de-watered by the berm, the berm material would be scooped and transported from the site for upland disposal.

Construction is dependent upon local sponsorship. The local sponsor would provide real estate easements and cost share 35 percent of the construction cost. The Corps is hopeful that construction can begin in 2001 and end in 2004. However,

compliance with this schedule would be contingent upon the sponsor's participation. Construction would occur during low-flow conditions and would generally be limited to only one of the four areas each year.

The following tools have been identified for use in conditions occurring throughout the 500-year floodplain:

5.1.1 Gravel Removal

Gravel removal would be used to varying degrees in the implementation of the various environmental restoration tools to provide more channel stability and provide sediment deposition in controlled areas. Principally gravel removal would be used to improve fish habitat, compensate for reductions in channel capacity, increase channel stability, and improve sediment transport. Gravel removal would be used to construct channel stabilization pools, secondary channels, and off-channel pools. All gravel removal would be accomplished using a track-mounted excavator, rubber-tired backhoe, or other similar equipment (along with trucks to transport the material to disposal and stockpile sites).

Areas (from which gravel is removed to maintain channel capacity and to construct channel stabilization pools and off-channel pools) would be rearmored on the bottom surface using cobbles screened from the excavated material. Gravels, which are removed, would be either transported to a site located between the levees for screening or would be transported as unscreened material to an existing gravel processing facility off-site. Screening would separate out cobbles 4-inch plus in diameter or larger for use as armoring material. It may be necessary to temporarily stockpile the screened material. The 4-inch minus material would be transported from the screening location by truck for off-site upland disposal prior to anticipated high flows. The 4-inch plus cobble would be transported by dump truck from the screening site to the channel capacity, side pool, and channel stabilization pool excavation sites and placed to rearmor the disturbed bed. The material would be dumped in wind-row fashion, perpendicular to the normal stream flow to allow subsequent high flows to naturally disperse the material. The 4-inch plus cobble would be placed prior to anticipated high flows.

5.1.2 Channel Capacity Excavations

Channel capacity excavation would be used to offset reductions resulting from construction of the environmental restoration tools and effects of the tools upon channel structure and function. Additionally, channel capacity excavation would compensate for ongoing channel aggradation and loss of channel capacity. Channel capacity would be reduced by the installation of anchored root wad logs; discharge of riprap to construct rock eco fences, spur dikes, and rock grade control; and from the deposition of bedload material and resultant regeneration of vegetation. Bedload deposition would be intentionally triggered by structures such as the eco fences and anchored root wad logs. Channel capacity excavations would be necessary to

compensate for the effects of the environmental restoration project and maintain the 100-year base flow for flood protection.

Gravel would be removed from specific areas of the channel to compensate for the decreases in channel capacity. Gravel would be removed within the general vicinity of the areas identified on plates 2, 3, 4, 5, and 6.

5.1.3 Channel Stabilization Pools

Channel stabilization pools reduce flow velocity, catch bedload material, and reduce the transport of bedload material to downstream areas, which may already have an over abundance of material. These functions improve channel stability and improve fish habitat through the creation of a large pool. Channel stabilization pools would be excavated in strategically selected locations to trigger the deposition of bedload material and sediments. See plates 2, 3, 5, and 6 for approximate locations.

5.1.4 Secondary Channels

Secondary channels, also referred to as supply channels, are typically smaller channels, which parallel the main river channel. Secondary channels vary in size and depth and may carry flows year-round or only during periods of high water. These channels help disperse flows and suspended sediments throughout the floodplain and provide valuable aquatic habitat.

Secondary channels would be constructed in selected locations to improve flows to existing off-channel pools or provide flows to newly constructed pools. See paragraph 5.1.5 for discussion of off-channel pools. Some secondary channels exist within the leveed sections of the river. However, because of accelerated flows, the channels are degraded or plugged. Gravel and cobble would be excavated to either enhance existing secondary channels or to construct new channels. See plates 2, 3, 4, 5, and 6 for approximate secondary channel locations and typical design.

Because of the remote locations and potential disturbances to wetland and riparian vegetation by trucks accessing the excavation sites, dredged cobble, gravel, and sand would either be scooped and side-cast on the adjacent gravel deposits or transported from the site for upland disposal. The determination of whether to side-cast material or transport it from the site would be based upon the potential impacts of ingress and egress of trucks to the site. If dump truck access routes are available, which would have minimal disturbance upon vegetation, the material would be scooped and transported to a permitted gravel processing facility for disposal. Excavated gravel and cobble may be screened, depending upon the proximity of the site to the gravel screening area and anticipated need for 4-inch plus cobbles to rearmor excavation sites. Side-cast material would be uniformly spread on adjacent unvegetated gravel deposits below the ordinary high water mark (OHWM), in the dry and above the low flow of the river. Fine sediments such

as silts, sands, and soils would be placed in locations to promote riparian habitat restoration.

5.1.5 Off-Channel Pools

Off-channel pools provide important spawning and rearing habitat for cutthroat trout. Access to potential spawning areas in spring creeks and secondary channels and pools has been severely reduced by construction of the levees. This lack of adequate spawning habitat is considered a major limiting factor for cutthroat trout in the Snake River.

Off-channel pools would be constructed within the alignment of the secondary channels to provide rearing habitat for cutthroat trout. See plates 2, 3, 4, 5, and 6 for approximate locations and typical design. Some existing pools would be used and may only require limited excavation to enhance their function. Other pools would require complete excavation.

Excavated cobble, gravel, and sand would be either scooped and side-cast on the adjacent gravel deposits or transported from the site for upland disposal. Depending upon the proximity of the site to the gravel screening area and anticipated need for 4-inch plus cobbles, the excavated gravel may be screened. Side-cast material would be uniformly spread. Side-casting would occur below the OHWM, in the dry, and above the low flow of the river. The determination of whether to side-cast material or transport it from the site would be based upon the potential impacts of ingress and egress of trucks to the site and the opportunity to enhance riparian habitat as described above. If dump truck access routes are available, which would have minimal disturbance upon vegetation, the material would be scooped and transported to a permitted gravel processing facility for disposal.

5.1.6 Spur Dikes

Spur dikes would provide areas of resting habitat close to areas of high velocity, which may transport high quantities of aquatic insects used as food by cutthroat trout and other species and provide protection against bank erosion. Spur dikes would be installed in areas where stream velocity is normally too high for fish to spend much time. These resting areas may be further enhanced with the incorporation of large-woody debris on the downstream side. The large-woody debris would be placed in areas of ineffective flow.

Spur dikes consist of a series of either kickers or bank barbs extending into the channel from the adjoining levee. See plates 2, 3, 5, and 9. Riprap used to construct the spur dikes would consist of large angular rock, free of fines. It is likely that spur dike construction would require in-water work. Both kickers and bank barbs would be composed of riprap armor. Kickers may extend as much as 60 feet from the levee. Random fill excavated to embed the kickers would be used as the core material. Equipment used to excavate for the kickers and to place riprap would

sit atop the levee and would maneuver onto the top of kickers, when necessary. Bank barbs, which are smaller than kickers, would extend up to 30 feet into the channel from the levee. Both type of structures would be embedded into the levee.

Photo 5-1. Bank Barb.

5.1.7 Eco Fences

Eco fences block, slow down, or deflect the force of the current during high-flow periods in order to protect existing islands and vegetation and to cause deposition of sediment where new vegetation may become established. Eco fences will allow the river to heal itself. Rather than the costly and disruptive process of placing sediments with heavy equipment, the river will be allowed to do the work through a natural process. See plates 2, 3, 4, and 5 for general eco fence locations. Eco fences would be placed at the front and sides of existing wooded islands to prevent/inhibit further soil and vegetation loss or placed in areas where soil and vegetation have already been lost to facilitate deposition and vegetation regrowth. As vegetation becomes established, it will further slow flow velocities and encourage accelerated sedimentation. Indirect aquatic habitat benefits would be gained as vegetation is reestablished. As the amount of vegetation increases, shade and material (such as leaves and insects that fall into the river, providing nutrients to river

organisms) would also increase while ensuring the future availability of large-woody debris input to the river.

Two different types of fences: piling eco fences (see photo 5-2, below) and rock eco fences, may be used. See plate 8 for detailed drawings. Piles would be driven and have interconnecting cables attached. Rock eco fences, constructed of riprap, would require excavation to key the structure into the cobble, gravel, and sand substrate. Excavated material would be scooped and transported off-site for upland disposal. Riprap would be trucked to the site and dumped directly into the excavation site. Riprap used to construct the rock eco fences will be large, angular rock, free of fine sediment.

Photo 5-2. Piling Eco Fence, with Accumulated Woody Debris.

5.1.8 Anchored Root Wad Logs

Anchored root wad logs consist of tree trunks with the root attached. Depending on placement, anchored root wad logs may provide additional resting habitat for cutthroat trout and other fish species. The 1989 Jackson Hole Debris Clearance Environmental Assessment found that, "local scour and fill is also evident adjacent to woody debris left in the channel following the 1986 flood." Anchored woody debris

may also encourage sediment deposition and help establish new vegetation (see photo 5-2).

Anchored root wad logs would be obtained from along the river channel within the four project areas or from commercial sources. Logs would be transported to the installation site by either truck, rubber-tired skidder, or helicopter. See plates 2, 3, 4, and 5 for approximate locations. A backhoe may be used to level an area to place the logs so that the logs would have uniform bearing along the trunk and its root would be partially embedded. The logs would be fastened down with toggle bolt anchors. The anchors would be driven into the ground with a jackhammer and a jack would be used to pull up on the anchors locking them into place. The cable would be tied around the logs and cinched down to tighten the logs to the ground. (See photo 5-3.)

Photo 5-3. Naturally occurring root wad logs and accumulated organic matter (woody debris). This would be replicated by anchoring root wad logs. During periods of high flows the anchored logs would trap smaller woody debris.

5.1.9 Rock Grade Control

Rock grade control structures keep the river from eroding and destroying existing riparian areas. Riprap would be placed at specific areas where down-cutting of the

channel threatens channel stability. Existing cobble, gravel, and sand would be removed to a standard uniform depth of 3 feet below the ground surface. See plates 4 and 9. The material would be scooped and transported off-site for upland disposal. This area would then be graded and refilled with riprap to match existing topography. Riprap would be transported to the site by truck, dumped, and spread using the anchore track-mounted excavator. Riprap used to construct the rock grade control would be large-angular rock, free of fine sediments.

5.2 MONITORING AND MAINTENANCE

Monitoring would be conducted during construction to ensure compliance with various requirements identified in the Biological Assessment (BA) (appendix A) and the Fish and Wildlife Coordination Act Report (CAR) (appendix B). Monitoring would also be conducted following completion of construction to assess changes to aquatic and terrestrial habitat; to identify effects of river flows on the structures, as well as effects of the structures on the river; and to identify the need for structure maintenance. Monitoring procedures for structure integrity and function and for aquatic and terrestrial habitat changes would be identified in a monitoring plan that would be developed prior to completion of the Jackson Hole, Wyoming, Environmental Restoration Project. The monitoring plan would be coordinated with the local sponsor and appropriate resource agencies prior to finalization. The local sponsor would monitor and maintain the environmental restoration measures.

During the first few years of use, an elevated level of maintenance may be necessary until information is gathered that may identify more efficient uses of structures. Certain structures are likely to require maintenance to ensure they continue to function as designed. The shifting nature of the braided river is expected to have some effect upon the structures; however, the extent of effects would vary between structures and from site to site depending upon river conditions. Some structures may require only minor maintenance while others might require substantial reconstruction. The frequency with which maintenance may be necessary and the extent of necessary repairs would be dictated by the frequency and extent of river effects upon the structures. Maintenance would likely be necessary to maintain and ensure the proper function of eco fences, secondary channels, channel stabilization pools, spur dikes, and off-channel pools. Maintenance is not expected to be necessary on the remaining environmental restoration tools; however, monitoring would be necessary to assess the need for maintenance.

It is unlikely that vegetative growth from the environmental restoration project will adversely impact flood control. The channel typically has adequate room to adjust its location and conveyance. This is particularly true if the channel alignment is stabilized and excessive erosion is reduced. The designated mid-channel pool areas will provide a means of maintaining adequate conveyance by removing excessive gravel before it has an opportunity to build up in the channel. However, it will be important to assure that "maintenance" does not involve activities that

progressively increase the cross-sectional area of protected vegetation at any point along the channel beyond that indicated in the original design drawings.

Maintenance of environmental restoration tools would be conducted in accordance with the limitations and restrictions of the EA and its appendixes. The local sponsor would be responsible for acquiring permits necessary to implement maintenance.

Monitoring and repairing of Jackson Hole Flood Control Project access roads and levees (affected by construction and subsequent maintenance activities) are discussed in paragraph 6.6 Transportation.

5.2.1 Channel Stabilization Pools

The quantity of sediment being transported downstream cannot be precisely calculated and is expected to vary from year to year. Because of this, the optimum size of channel stabilization pools, and their anticipated effectiveness, is not known. Removal of gravel from channel stabilization pools, to maintain channel stabilization pools, would generally occur when one-half or more of the original channel stabilization pool gravel volume is refilled. Only about 50 percent of the original trap area would need to be disturbed to remove the quantity necessary to maintain the trap. Excavation would not vary from or exceed the original trap design. The traps would have to be closely monitored to ensure excessive excavation does not occur. Under average conditions, several years may be necessary to fill the traps; however, it is possible that a single flood event could fill the traps completely. Experience over time will determine the appropriate level of maintenance.

5.2.2 Secondary Channels

The deposit of gravel and subsequent blockage of the upper end of the channel would necessitate maintenance. If groundwater is inadequate, the secondary channels would need to be reopened to provide an adequate inflow of water for the downstream pools. Gravel blockages would be excavated sufficiently to provide 2 to 3 cubic feet per second (cfs) flow. Excavated gravel would be side-cast due to the anticipated small quantity.

5.2.3 Off-Channel Pools

Off-channel pools would be subject to refilling during high-flow seasons. Pools that are close to the main channel could be refilled with gravel and cobbles in a single high-flow season. Those farther away would likely last a number of years, refilling with silt and sand brought in by the interconnecting channels and by general over-bank flow during high-flow periods. Due to the braided nature of the river, it is nearly impossible to select locations where pools would always be protected from potential destruction by major flood flows or channel changes. Based on this, various approaches to maintaining off-channel pools would be used.

Pools near the margins of the active meander belt would be allowed to fill completely. A new pool would then be constructed nearby, without disturbing the old pool or its water supply. Where possible, the new pools would be built either upstream or downstream of the existing pools in order to use the same supply channels. Pools constructed near the main channel in the vegetation-free areas of the channel would be reexcavated only when completely filled with gravel. These channels could be filled in completely during a major event, which could also involve major changes in the main channel. The main channel may even cut a course through the center of a pool. In the latter case, the pool would be reexcavated at another location (probably along the previously abandoned channel). The objective would be to approximately maintain the same area of pools throughout the life of the environmental restoration project either by reexcavation at the same location or relocation of a pool to a more advantageous site. Maintenance would be performed during the low-flow period.

5.2.4 Spur Dikes

Spur dikes would occasionally be damaged by high flows. Measurements, taken at various locations on the existing channel, indicate that erosion can extend down to at least 15 feet below the high-water level. The mode of damage most likely to occur would be undercutting of the toe of the dike and collapse of material into the void with material being transported downstream. Maintenance of bank barbs or kickers would generally involve reestablishment of the toe and restoration to the original geometric outline. Maintenance could include placement of additional bank or toe protection, strategic placement of boulders or intermediate barbs to break up the undesirable flow pattern if undesirable flow patterns are created. In a worst-case scenario, the spur dike group can be removed. It is anticipated that a staged construction sequence will allow design adjustments to be made as experience is gained from the performance of these structures.

5.2.5 Eco Fences

Maintenance measures for the eco fences should provide for minimal adjustment of fence lengths or alignment, repair of damaged cables or piling, and reestablishment of the fence tie-off to the bankline if erosion damage threatens to destroy the function of the fence, increase bank erosion, or threaten adjacent flood control structures. This could involve removal of some portions of fence if it proved to be poorly aligned or improperly located.

Maintenance would most likely be necessitated by failed posts and fencing or by erosion around the landward end of the fence. Repair would involve reestablishment of the fence tie-off by extending the fence back to the undisturbed bankline. Repairs may include repositioning existing piles and cable, installing longer posts, reattaching the cables, or adding other material to trap debris. In some cases, it might be sufficient to drive and attach additional supporting posts in

locations where the fence is beginning to sag or fail. Work would be done during low flows.

Depending upon how the river affects the fence site, maintenance work may or may not occur in the water. If a fence is failing to catch debris, trapping efficiency might be increased by adding a finer mesh screen that would capture smaller debris, or exposed areas may be covered by dragging some of the debris over to places where it is deficient. If debris is failing to be trapped or is being deflected around the fence, it may be necessary to add one or more fence panels oriented upstream near the end of each fence. In some areas, adjustments in the location or angle of eco fences may be needed if the river abandons the channel.

6.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

6.1 WATER

The Snake River and its tributaries in the upper Snake River Basin have regular patterns of natural seasonal flow with high flows during the months of May through July, receding flows in August and September, and low flows in the months of October through April. High flows in the late spring and early summer result from melting of the winter-accumulated snow pack, sometimes augmented by rain storms. Winter flooding due to thawing conditions and rain-on-snow conditions can occur but rarely result in damaging flows. For the period of record, maximum annual peak discharges have always coincided with the spring snowmelt season. Total annual runoffs for a given area vary with the amounts of precipitation received during the snow pack accumulation and the snowmelt seasons.

The porous and unconsolidated alluvial and glacial deposits in the valley are the major aquifers in Teton County. Much of the floodplain is close to the level of the river and laced with abandoned or relief channels. Due to the ready exchange of water between the river and the aquifer, channels that are abandoned or cutoff by levees often still contain flowing or standing water. Along the Snake River and its major tributaries, the aquifer can supply very large amounts of water. Water tables are often less than 5 feet below the ground surface for a significant portion of the year. Groundwater levels, reflecting the surface runoff patterns, are highest in the spring and early summer and lowest later in the fall and early winter. Spring-fed watercourses will rise in tandem with the snowmelt runoff in the main streams, but the increase in flow is of a much lesser magnitude and does not seem to approach damaging levels.

Numerous irrigated diversions remove water from the Snake River. The irrigation season generally lasts from about May 1 to October 1. There are currently eight active diversions within the Federal Levee Project area and an additional eight inactive diversions. Regulation by the use of storage space in Jackson Lake reduces the Snake River flow during October through May, or early June, and augments Snake River natural flows during July, August, and September in order to satisfy downstream irrigation requirements.

6.1.1 Opportunities for Water Flow Regulation Using Jackson Lake.

Changes in the operation of Jackson Lake could improve fish habitat and/or reduce erosion in the Snake River. Such changes might include regulation of peak flows and summer releases and regulation to augment minimum flows.

6.1.1.1 Regulation of Peak Flows and Summer Releases.

Between 1917 and 1956, Jackson Lake was regulated primarily in the interest of irrigation storage, with only incidental flood control benefits. These operational policies resulted in an average reduction in the annual unregulated peak discharges of about 4,600 cfs. Because the reservoir was occasionally refilled prior to the occurrence of the actual flood peak, in some years no significant control was achieved. During some low water years, the high summer irrigation releases exceeded the natural peak inflow. In addition, sustained high flows, at or near bankfull, were blamed for increased bank erosion in unleveed reaches of the river. In the 1940's, local interests began pressing for changes in the operation of Jackson Dam that would address the problem of local bank erosion. With the construction of Palisades Dam, up to 350,000 acre-feet of flood control space (25 percent of the total 1,400,000 acre-feet available in Palisades Reservoir) was made available for use in Jackson Lake operational plans.

The formal implementation of this provision went into effect in 1956 when the Palisades Water Control Manual was published. The primary objective of the provision was to limit flows to a maximum of 20,000 cfs below Palisades Dam while providing significant, but less reliable, control upstream. Typically, the Bureau of Reclamation evacuates a minimum of 200,000 acre-feet of space from Jackson Lake with releases that may be higher than inflow during the irrigation season. Additional space can be evacuated depending on runoff forecasts prior to May 1. If the reservoir has been drawn down below the minimum flood control space on October 1, this deficit may be recovered by gradually refilling during the winter. An attempt is made to limit releases to the 5,000 to 7,000 cfs range during the peak runoff period, although these may be reduced as necessary in an attempt to limit peak flows at the Flat Creek gage to 20,000 cfs. During the period 1956 to 1986, Jackson Lake regulation achieved an average reduction in the annual peak flow at the Wilson gage of 6,200 cfs, compared to 4,600 cfs prior to 1956. In the years since 1956, regulated peak flows at the Wilson gage have exceeded 20,000 cfs 4 times (in 1982, 1986, 1996, and 1997) compared to 12 times prior to 1956. However, of the 12 times prior to 1956, only 1 (in 1943) occurred during the period 1930 to 1956. The remaining 11 occurred prior to 1930.

Although flood control regulation has been improved by Jackson Lake operations, sustained, near bankfull flows in the Jackson Hole area (about 10,000 cfs) probably continue to contribute to bank erosion problems in the area outside the Federal levee reach. Based on records from the two U.S. Geological Service (USGS) gages, the Snake River near Wilson and below Flat Creek (from 1973 to 1986) sustained flows exceeding 11,000 cfs occurred an average of 4 weeks each year.

Flood control regulation between Jackson Lake and Palisades Reservoir has been less than optimum due to the high priorities placed on irrigation storage at Jackson Lake and the emphasis on flood control below Palisades Dam. But, unless major changes are made in Congressional authorizations for the Jackson-Palisades

system and in current irrigation contracts and interstate compacts, any improvements arising from new studies would likely be marginal. The potential for peak flow reduction downstream of the Jackson Dam project is also limited by the fact that only about 38 percent of the Snake River runoff at the Flat Creek gage is controlled by Jackson Lake. To significantly improve the opportunity for peak flow reduction would require construction of additional upstream storage facilities.

6.1.1.2 Regulation for Minimum Flow Augmentation.

Jackson Hole is a recreational haven for thousands of visitors each year. Recreational fisheries are an important element in the all-season attraction of the region. Reservoir levels at Jackson Lake have been regulated to maintain optimum breeding and nursery conditions. This has usually meant holding the pool elevation constant from October 1 (the end of irrigation season and approximately the middle of Mackinaw egg-laying season) until the eggs hatch in the spring.

However, recognizing cutthroat trout as an important resource, fisheries managers have determined that a minimum stream flow of 280 cfs from Jackson Lake is required to support a healthy population of cutthroat trout. The optimum flow is 400 cfs, and flows above 600 cfs should be avoided. To implement this plan, the lake could be drawn down as much as 5 feet after October 1 to maintain stream flows below the dam. There is an attempt to meet the 280 cfs minimum but no formal minimum release requirement. The Bureau of Reclamation, *Operations Manual*, December 1997, states in part: "If the reservoir was drawn down to the minimum flood control space on October 1, then the release is set to match inflow. If the reservoir was drawn down below the minimum flood control space on October 1, then the release can be set to a minimum inflow or 280 cfs whichever is less. The release selected will allow the reservoir to either refill to the minimum flood control space gradually over the winter or refill as much as possible up to the minimum flood control space."

Without Jackson Lake Dam, flows would have dipped below 400 cfs in each of the last 87 years and dropped below 280 cfs in 74 of those years. Statistically, stream flows have been less than 400 cfs 21.1 percent of the time and less than 280 cfs for 5.5 percent of the time.

With Jackson Lake Dam in place, there were 9 years since 1909 with average annual flows less than 1,000 cfs. The lowest average annual flow year was 1977 with an average annual flow of 660 cfs. If flows above 4,000 cfs are excluded because they occurred during floods and may not have been held by a moderate size dam, then there were 15 years with average annual flows less than 1,000 cfs. Of these, six occurred as back-to-back pairs. Again, the lowest average annual flow was 660 cfs in 1977.

During the construction of Palisades Dam in 1956, the Corps negotiated 800,000 acre-feet of nonexclusive flood control storage at the 2 projects with 25 percent

coming from Jackson Lake and 75 percent coming from Palisades Dam. The agreement requires the Bureau of Reclamation to make the storage available between March 1 and May 1 each year unless the Corps and Bureau of Reclamation agree in advance that expected spring runoff would be better controlled by different operation.

Although snow melt forecasting has come a long way, the exact timing and quantity of runoff is still subject to considerable error. The 1997 spring runoff was nearly 50 percent greater than anticipated, forcing both dams into defensive operation and causing severe flooding downstream.

For the current study, a representative sample of flow periods was selected that reflect current operating needs of downstream irrigators as interpreted by the Bureau of Reclamation Reservoir Operations Center. Both 1992 and 1994 were classic low-flow years. The 5-year period extending from October 1991 through September 1996 appeared to provide a full range of possibilities including the two drought years of 1992 and 1994, as well as an unusually high runoff year in 1996. This period was selected for further detailed analysis.

Table 6-1 is a list of "natural" (flows assuming no Jackson Lake regulation) Snake River flows at the Jackson-Wilson Bridge ranked by peak flow and volume:

Table 6-1. Unregulated Flows at Snake River at Jackson-Wilson Bridge.

Ranking by Peak		Ranking by Volume	
Date	**Discharge (cfs)**	**Date**	**Volume (kaf[1/])**
06 06 97	34,120	06 06 97	3,970
06 02 86	32,520	06 24 71	3,565
06 16 74	30,540	06 10 96	3,414
06 13 18	30,230	06 29 82	3,369
06 10 96	30,090	06 02 86	3,297
06 24 71	28,170	06 02 56	3,248
06 02 56	27,550	06 16 74	3,235
06 09 81	27,530	06 21 43	3,233
06 29 82	26,070	06 09 72	3,230
06 09 72	25,590	05 26 13	3,205
06 20 17	24,790	06 13 18	3,176
05 21 54	24,430	06 14 27	3,155
05 27 28	24,240	06 13 65	3,149
06 08 12	23,420	05 27 28	3,087
06 06 57	23,330	06 06 76	3,062
06 14 27	23,260	06 20 17	3,057
06 13 65	23,210	05 21 25	2,962

[1/] 1,000 acre-feet.

Table 6-1. Unregulated Flows at Snake River at Jackson-Wilson Bridge (continued).

Ranking by Peak		Ranking by Volume	
Date	**Discharge (cfs)**	**Date**	**Volume (kaf)**
05 26 13	22,060	06 08 12	2,952
06 09 89	22,060	05 29 51	2,938
05 29 51	21,930	06 16 11	2,906
06 06 95	21,670	06 17 16	2,899
05 22 93	21,670	06 10 78	2,879
06 06 76	21,450	06 01 84	2,841
06 16 11	21,380	06 05 14	2,826
06 06 52	20,800	06 11 21	2,807
06 10 78	20,530	06 11 83	2,799
06 01 84	20,520	06 07 50	2,764
06 14 53	20,480	06 06 95	2,703
06 07 50	20,350	06 13 62	2,683
06 17 16	20,290	06 06 52	2,640
06 09 70	20,230	06 06 57	2,619
05 21 25	20,120	07 04 75	2,614
06 03 48	20,020	05 21 54	2,595
06 21 43	19,980	05 15 36	2,594
05 15 36	19,850	06 07 22	2,546
06 15 59	19,790	06 07 38	2,545
05 24 80	19,480	05 10 47	2,539
05 28 79	19,260	06 21 67	2,535
05 28 79	19,260	06 21 67	2,535
06 07 38	19,160	06 09 20	2,487
06 11 21	19,130	06 09 70	2,447
06 11 83	19,020	06 07 64	2,426
07 04 75	18,970	05 25 23	2,410
06 15 63	18,900	06 09 89	2,399
06 21 67	18,350	05 27 69	2,394
06 05 91	18,120	06 06 46	2,394
06 05 14	18,020	05 22 93	2,382
06 09 20	18,010	06 12 49	2,371
05 25 58	17,960	06 13 68	2,331
06 07 64	17,930	05 21 32	2,311
06 07 22	17,890	06 03 48	2,279
06 13 35	17,330	05 24 80	2,272
06 13 33	16,650	06 05 91	2,250
06 06 46	16,520	05 28 79	2,240
06 12 49	16,430	05 27 85	2,203
05 25 23	16,380	06 15 63	2,169
06 13 68	16,320	06 15 59	2,149
05 27 69	16,210	06 14 53	2,137

Table 6-1. Unregulated Flows at Snake River at Jackson-Wilson Bridge (continued).

Ranking by Peak		Ranking by Volume	
Date	**Discharge (cfs)**	**Date**	**Volume (kaf)**
05 21 32	15,960	05 17 39	2,113
06 13 62	15,720	06 09 42	2,106
05 10 47	15,710	06 25 45	2,103
06 13 55	15,490	05 24 29	2,092
06 25 45	15,460	06 09 81	2,073
05 27 61	15,390	06 13 35	2,065
05 27 85	15,010	06 13 33	2,044
05 31 66	14,990	05 30 30	2,031
05 21 73	14,820	06 11 90	2,028
06 09 42	14,350	05 31 66	2,017
05 28 37	14,270	06 13 55	1,975
05 13 94	14,190	05 21 73	1,952
05 24 29	13,730	06 02 44	1,935
06 11 90	13,420	06 01 15	1,917
06 03 60	13,300	05 28 37	1,900
05 28 88	12,590	05 24 26	1,882
05 30 30	12,370	05 28 19	1,851
05 28 19	12,330	05 25 58	1,821
05 17 39	11,120	05 26 41	1,818
05 26 40	11,080	05 27 61	1,806
05 26 41	10,880	06 03 60	1,805
05 18 24	10,780	05 19 87	1,780
06 01 15	10,620	05 26 40	1,733
06 02 44	10,390	05 18 24	1,707
05 24 26	10,290	05 13 94	1,642
05 08 92	9,870	05 08 92	1,640
05 19 87	9,700	05 28 88	1,617
06 09 77	8,820	06 02 31	1,433
05 07 34	8,690	05 07 34	1,399
06 02 31	8,610	06 09 77	1,328

Assuming reasonable forecasting, volume becomes a more important indicator of low-flow capability than peak flow. Not surprisingly, irrigation demands are higher in low-flow years than in normal years due to dry conditions everywhere else in the basin. The basin runoff volume for 1994 was the sixth lowest flow on record and in 1992 was the fifth lowest flow on record. The 1994 volume record was chosen as the test case for low-flow discharge because it is recent in history and had a very low flow. Irrigation demands in 1992 were considered too extreme for the present analysis.

The 1994 hydrograph of mean daily flows indicated the summer runoff of July subsided into the irrigation demand curve of August. The 1994 irrigation demand

was then superimposed on the 5-year test period from October 1, 1991, to December 12, 1996, to determine if optimum low flows could be maintained.

The U.S. Army Hydrologic Engineering Center's (HEC) model HEC-5, "Simulation of Flood Control and Conservation Systems," was used to route the flows through Jackson Lake. The following four criteria were used for annual flow routing:

- maintain a minimum flow of 400 cfs below the dam;
- maintain minimum irrigation flows at Jackson-Wilson Bridge equal to 1994;
- draw Jackson Lake down to elevation 6,755 by October 10; and
- do not exceed 15,000 cfs at Jackson-Wilson Bridge.

The 1994 irrigation demand curve was repeated during each year of the simulation. The simulated hydrograph indicated that a low flow of 400 cfs was maintained even during the two drought years of 1992 and 1994. This analysis indicated that the 400 cfs minimum could be maintained during the winter if irrigation demand was the same each year. In the draught year of 1992, the irrigation demand was considerably higher than normal, resulting in an October 1 pool level that was several feet lower than would normally occur at this time of the year. It was so low that it would not have been possible to refill the reservoir if 400 cfs had been released during the fall and winter months. Based on the analysis to date, it appears that the 400 cfs could be maintained during normal flow years, but that during drought years similar to 1992, this level of release could not be achieved while still meeting the irrigation demands for the following year. It should be emphasized that the Bureau of Reclamation operates Jackson Dam. They are in a better position to consider all of the operational constraints and should be the agency that makes the final determination whether additional winter-flow augmentation is possible.

6.2 AQUATIC ENVIRONMENT

A wide variety of aquatic organisms are located within the environmental restoration project boundaries. Construction and maintenance of the restoration can cause short-term adverse impacts to some of these organisms. The long-term positive benefits created through the successful environmental restoration project would far outweigh these short-term impacts. A period of several years between maintenance excavations would be desirable. This would help minimize recurring impacts to the aquatic environment. Impacts to various groups of organisms are discussed in the following sections.

6.2.1. Fish

6.2.1.1 Cutthroat Trout

Cutthroat trout are the main fish species of concern in the environmental restoration project area. The WGFD has designated the Snake River in the project area as a Class 1 or a blue ribbon trout stream. This indicates that the river is of national

importance as a trout stream and should receive high priority for protection (Kiefling 1978, Corps 1989). Cutthroat trout populations in the area are mainly limited by lack of adequate spawning areas. Access to spring creeks and side channels, which are used for spawning, has been severely reduced due to construction of flood control levees. In addition to access restrictions, flow patterns within spawning channels have been altered, which further reduces useable spawning habitat.

Spawning habitat is considered one of the major limiting factors for cutthroat trout (USFWS 1988, Erickson 1980, Corps 1989). Most cutthroat trout spawning occurs during March through June in the spring creeks that enter the river along the project reach (Kiefling 1978, Corps 1989). The openings of many of these spring creeks are currently blocked by levees. Spawning is limited or non existent in the Snake River because of several factors. These include spring flows carrying high bedloads, high turbidity, human-induced modifications of the channel, and a cobble substrate that is typically too large for cutthroat trout spawning (Kiefling 1978, Erickson 1980, USFWS 1988, Corps 1989).

Another factor limiting cutthroat trout populations is the lack of overwintering habitat. Results from an in-stream flow study conducted above the project reach of the Snake River suggests that low-flow overwintering habitat is limited (Annear 1989, Corps 1989). Aquatic habitat associated with pools with cover present is often more important during winter low-flow periods (Lestelle and Cederholm 1984, Murphy et al. 1984, Swales et al. 1986, Bustard and Narver 1975b, Corps 1989). In many areas, it has been shown that structures formed by large-woody debris contribute significantly to the total habitat in streams for cutthroat trout and salmon (Corps 1989). Because of a lack of slow, deep pools, or other flow diversions, low flows and ice formation in the winter can severely limit habitat useable by cutthroat trout during the winter. Lack of overwintering habitat appears to cause high mortality in young age classes of cutthroat trout in the Snake River system (Kiefling 1978).

Baseline cutthroat trout habitat data was measured in October 1998. Resting pool area for use by cutthroat trout during the winter was the main habitat type considered. Figure 6-1 shows that fish habitat would increase as soon as environmental restoration project in-stream structures are installed. Additional figures for each work area can be found in appendix C. There may be a further increase as riparian vegetation increases. The "with project" projections shown in Figure 6-1 are based on implementation of all proposed structures and environmental restoration tools. If no action is taken, fish habitat would decrease in the future. It is important that habitat data is collected at the same time of year annually for the best comparisons between years.

Figure 6-1. All Four Areas - Fish Habitat Unit Projections.

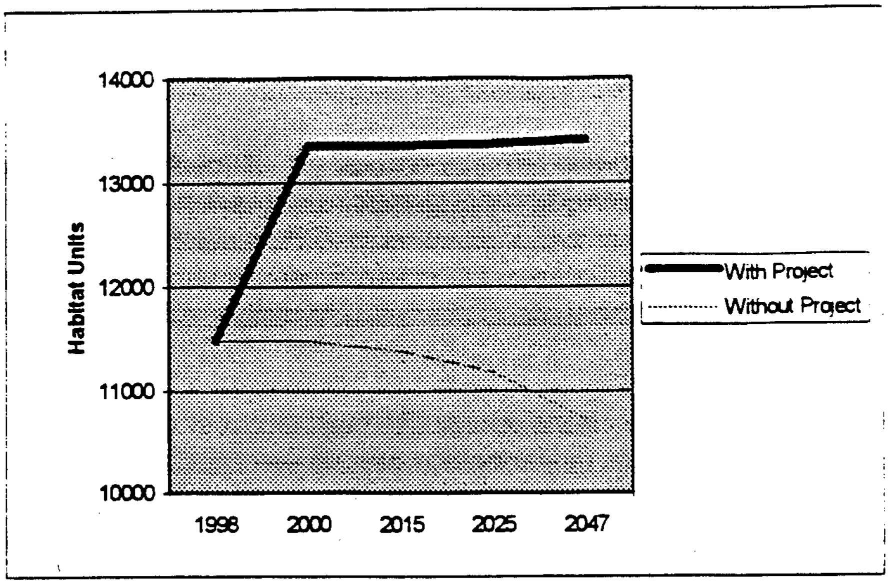


Table 6-2 lists the distribution of pool habitat type by area. There was an estimated 114,689 square feet of pool habitat in the evaluated sections of the areas.

Table 6-2. Square Feet of Pool Habitat Classes.

Area	Pool Class		Pool Area
1	3		1,076
	2		646
	1		9,903
		Total	**11,625**
4	3		23,412
	2		11,840
	1		11,087
		Total	**46,339**
9	3		1,830
	2		6,243
	1		15,070
		Total	**23,143**
10	3		4,305
	2		4,520
	1		24,757
		Total	**33,582**
	Grand Total		**114,689**

Pool class is important for determining the relative cutthroat trout habitat value for individual pool areas. Pools of different classes provide different amounts and quality of cover. Pool classes associated with the highest standing crops of cutthroat trout are assumed to be optimum. First class pools are large and deep. Pool depth and size are sufficient to provide a low velocity resting area for several

adult cutthroat trout. More than 30 percent of the pool bottom provides cover due to depth, surface turbulence, or the presence of structures (*e.g.*, logs, debris piles, boulders, or overhanging banks and vegetation). The greatest pool depth is greater than or equal to 6.6 feet deep in streams greater than 16.4 feet wide.

Second class pools have moderate size and depth. Pool depth and size are sufficient to provide a low velocity resting area for a few adult cutthroat trout. From 5 to 30 percent of the bottom provides cover due to surface turbulence, depth, or the presence of structures. Typical second class pools are large eddies behind boulders and low velocity, moderately deep areas beneath overhanging banks and vegetation.

Third class pools are small or shallow or both. Pool depth and size are sufficient to provide a low velocity resting area for one to very few adult cutthroat trout. Cover, if present, is in the form of shade, surface turbulence, or very limited structure. Typical third class pools are wide, shallow pool areas of streams or small eddies behind boulders. Virtually the entire bottom area can be seen (Hickman et al. 1982).

This environmental restoration project is designed to increase the amount of overwintering and rearing habitat available to cutthroat trout, as well as to protect existing riparian areas from frequent high-water events. Total pool area within the study reaches would increase. Class 1 and 2 pools would increase most and provide the greatest benefit. Simply improving overwintering and rearing habitat may not increase the cutthroat trout population. However, by increasing these types of habitat, more or healthier cutthroat trout may survive to spawn, which could increase the population. Protecting and reestablishing vegetation between the levees would also be a benefit by providing organic material to the stream. This organic material could be used directly by fish in the form of terrestrial insects or cover, or indirectly when bacteria colonize on the organic material and are eaten by aquatic invertebrates that are then eaten by fish.

In-water construction would temporarily displace cutthroat trout from a few hours to a few months. Cutthroat trout may move into construction areas such as spur dikes as soon as equipment leaves the area. However, they may not inhabit large gravel removal areas for up to a few months until aquatic invertebrates recolonize the area. The area of impact would be limited because most gravel removal would take place in areas above the low-flow channel. Construction of eco fences and anchored-woody debris would have little effect on cutthroat trout as long as there are no in-water discharges. Spur dikes would create areas of low velocity resting habitat that would be used by cutthroat trout. Environmental restoration tools that protect or reestablish vegetation between the levees would provide a long-term benefit for cutthroat trout. Maintenance on the environmental restoration tools would have effects similar to construction. The least amount of activity necessary to maintain the environmental restoration tools would cause the least amount of impacts.

6.2.1.2 Other Game Fish Species

Mountain whitefish (*Prosopium williamsoni*) are abundant in the Snake River. This species may compete with cutthroat trout for food, but only at a limited level in the Snake River (Kiefling 1978, Corps 1989). Other salmonids are present in the region, but in relatively low abundance. They include brook trout (*Savelinus fontinalis*), brown trout (*Salmo trutta*), rainbow trout (*Oncorhynchus mykiss*), lake trout (*Savelinus namaycuch*), and possibly grayling (*Thymallus arcticus*) (Kiefling 1978, USFWS 1988, Corps 1989).

An increased amount of overwintering habitat would also be used by these species. The overall population distribution is not expected to change. Construction, maintenance, and long-term effects for these game fish species would be similar to the effects on cutthroat trout.

6.2.1.3 Non-Game Fish Species

Suckers (Catostomids) are an important food source for bald eagles (USFWS 1988, Corps 1989). Sculpins (Cottids) are a major prey item for cutthroat trout (Kiefling 1978). Five species of minnows (Cyprinids) are present in the Snake River. These small fish may be used as prey by cutthroat trout (Kiefling 1978, Corps 1989).

Excavation within gravel removal areas may displace some non-game fish species. Some mortality on small fish is expected in areas of in-water excavation, such as sculpins and minnows that may hide in the substrate instead of leaving the area. It is not expected that this would have noticeable long-term population effects on these species. By creating temporary berms and working on dry gravel bars during low-flow periods, adverse effects would be minimized. Non-game fish may also avoid gravel removal areas until aquatic invertebrates recolonize the area.

If vegetation between the levees is dramatically increased and the amount of organic material in the river increases, it is possible populations of these species may increase, which could provide more food for species that prey on them. Maintenance would have effects similar to construction but be temporary and localized.

6.2.2 Aquatic Invertebrates

Aquatic invertebrates are a primary food source for all carnivorous fish in the Snake River. A variety of species are present. Kroger (1967) found that 98 percent of the sampled biomass was comprised of mayflies (Ephemeroptera), true flies (Diptera), caddisflies (Tricoptera), and stoneflies (Plecoptera). Four genera of caddisflies produce the highest biomass of insects in the Snake River. Kiefling (1978) found a similar composition and abundance in the Gros Ventre River.

Most aquatic invertebrates identified in the Snake River are herbivores and detritivores, although a few are carnivores (Kroger 1967). Of the six most abundant

species of caddisflies, three are herbivorous and three are carnivorous. The mayflies are predominately herbivorous. The stoneflies have the most varied diet, being both herbivorous and carnivorous. The true flies are generally herbivorous. Their larvae are an important food source to carnivorous invertebrates.

There may be a decrease in abundance of aquatic invertebrates in gravel removal areas due to excavation. However, this decrease is expected to be short-term. By working on dry gravel bars during low-flow periods, adverse effects would be minimized. Aquatic invertebrates should recolonize gravel removal areas within a few months. The species composition would depend on factors such as velocity, depth, and substrate size. Species composition may change in areas where structures are installed that change the flow conditions.

The overall abundance of aquatic invertebrates should not change noticeably until organic material input and entrapment in the stream increases. This could lead to an increase in the abundance of aquatic invertebrates.

Maintenance would have little effect on aquatic invertebrates except in-water excavations, which could cause temporary localized reductions in some species.

6.2.3 Aquatic Plants and Algae

True aquatic communities are supported by standing or flowing water year-round and are composed primarily of white buttercup (*Ranunculus aquatilis*), yellow buttercup (*R. cymbalarai*), speedwell (*Veronica americana*), waterweed (*Elodea* spp.), pondweed (*Potamogeton* spp.), watercress (*Rorippa nasturtium-aquaticum*), water milfoil (*Myriophyllum* spp.), mare's tail (*Hippuris*), and duckweed (*Lemna* spp.). White buttercup commonly forms large mats in shallow, standing water. Mat-forming algae is also common in shallow, stagnant ponds. Liverwort and stonewart species are also common.

The cobble-gravel bottom communities are dominated by foxtail (*Alopecurus aequalis*), silverberry (*Eleagnus commutata*), willow (*Salix* spp.), timothy (*Phleum pratense*), sedge (*Carex* spp.), muhly (*Muhlenbergia*), sweet clover (*Melilotus officinalis*), horsetail (*Equistum* spp.), and dock (*Rumex* spp.).

Some plants would be impacted during construction and maintenance. They may be run over by equipment or dug up in excavation areas. However, the plants growing in gravel removal areas would generally only survive until the next high flow. As an additional measure, access routes to construction sites would be selected to minimize impacts to existing plants.

Creation of shallow, low velocity pools may encourage the growth of some aquatic plants and algae. Species compositions would be determined by factors such as depth, velocity, and available nutrients. This increase would only be present until the areas refill with bedload. Debris fences, channel stabilization, and anchored

woody debris may provide enough protection to some areas to allow for longer survival of some plant species. This longer survival may provide bank stability and organic matter to the stream, as well as other environmental benefits. Maintenance impacts would be similar to initial construction impacts but be temporary and localized.

6.3 TERRESTRIAL ENVIRONMENT

This environmental restoration project, if implemented, would have great potential for improving the terrestrial habitat within the confines of the four areas. Habitat Evaluation Procedures (HEP) were used to determine the relative habitat values of the four sites. Habitat value is measured in relation to the wildlife species that derive benefit (*i.e.*, cover, food, water, nesting, *etc.*) from the habitat.

Yellow warbler and song sparrow were chosen as the two species that would use the majority of the shrubby/woody habitat associated with the upper Snake River floodplain. A yellow warbler likes medium-sized shrub habitat comprised primarily of coyote willow and other willow species along streams. This type of habitat is referred to as riparian or palustrine scrub-shrub (PSS). The song sparrow likes thick brushy areas and dense forbs near streams. The habitat is comprised of rose, berry vines, currant, and young poplar trees referred to as understory riparian or palustrine forest (PF). The habitat values or habitat suitability indexes (HSI) are obtained by measuring the environmental variables associated with each species.

The acreage for the two habitat types (PSS and PF) were obtained for each work area by mapping the covertypes from aerial photography. The years of photography used were 1956, 1991, and 1996. From the acreage figures derived from these sets of photography, HSI values were applied to each acre of habitat. For example, if the song sparrow has an HSI of 0.5, then the habitat units found on 50 acres of PF is 25. If a yellow warbler has an HSI of 0.4, then the number of habitat units found on 100 acres of PSS is 40. The HSI values are always a figure between 0 and 1.

The trend of the habitat unit increases with the environmental restoration project and decreases with out the project for both the yellow warbler (PSS) and song sparrow (PF). Future habitat value is based on an estimate of vegetative growth or degradation that could result if the project is implemented as planned or if the area is left as it is today. Figures for each work area can be found in appendix C.

As depicted in figures 6-2 and 6-3, there is great potential for terrestrial habitat improvement along the river corridor between the levees if the environmental restoration project is implemented as planned. If the project is not implemented, the riparian vegetation in the river corridor would continue to degrade.

6.3.1 Vegetation

The vegetation in the upper Snake River drainage near Jackson, Wyoming, is typical of the central Rocky Mountain region. Upland vegetation types in the area include: sagebrush-grassland, lodgepole pine/Douglas fir, and subalpine fir/Engleman spruce (Corps 1994). The sagebrush-grassland type occurs on the glacial outwash plains and terraces above the floodplain. This type is dominated by sagebrush (*Artemisia tridentata*) and perennial grasses, *e.g.*, wheatgrasses (*Agropyron* spp.); fescues (*Festuca* spp.); and bluegrasses (*Poa* spp.). Forests dominated by lodgepole pine (*Pinus contorta*) occur at lower elevations (6,300 to 7,800 feet) along rivers and above the glacial outwash plain. Douglas fir (*Psuedotsuga menziesii*) intermixes with lodgepole pine, but is generally dominant only on ridge tops and east-facing slopes. Subalpine fir (*Abies lasiocarpa*) and Engleman spruce (*Picea englemanii*) dominate higher elevation (7,800 to 10,000 feet) forests (Corps 1994).

The floodplain along the Snake River and its tributaries includes mixed deciduous/coniferous forests and wetlands. Floodplain forest consists of narrow-leaf cottonwood (*Populus angustifolia*) and willow (*Salix* spp.) intermixed with Engleman and blue spruce (*Picea pungens*). Wetlands occur where the water table is high enough to support hydrophytic plants (*i.e.*, plant species that grow in water or on a substrate that is at least periodically deficient in oxygen as a result of excessive water content). These include three major types: PSS, palustrine emergent, and aquatic bed (Corps 1994). The PSS wetlands are found primarily on stable gravel bars and dikes and are dominated by willow and mountain alder (*Alnus incana*). Sedges (*Carex* spp.), cattails (*Typha* spp.), and bulrush (*Scirpus* spp.) are the primary species in palustrine emergent wetlands. The dominant species in aquatic bed wetlands depend on bottom substrate. Aquatic beds along shorelines tend to support watercress. Pondweed is common in streams or ponds with silt bottoms; ballhead waterleaf (*Hydrophyllum capitatum*) occurs in rocky substrates (Corps 1994).

Over 30 rare plant species tracked by the Wyoming Natural Diversity Database (WYNDD) occur in the vicinity of Jackson Hole Levees (table 6-3; Corps 1994). None of these species are Federally listed or proposed as threatened or endangered, but three are protected on U.S. Forest Service (USFS) lands. Those species listed in table 6-3 are considered extremely rare (5 or fewer occurrences) to rare (21 to 100 occurrences) in Wyoming or regionally. It is highly unlikely any of these species occur within the work areas between the levees. The west side of Area 4 and east side of Area 1 would have wetland habitat that includes moist soil plants that may include those listed in table 6-3 (Corps 1994). Work should not take place outside of gravel bars or gravel channels that feed from the main river channel. Work would disturb the cobble soils within the river corridor. Care must be taken to minimize these disturbances. Monitoring for noxious weeds would be needed to ensure they do not spread within areas above the primary flood zone of the river channel.

6.3.2 Wildlife

The Jackson Hole, Wyoming, area is known for its diverse wildlife in the valley and surrounding mountains. The following paragraphs describe the dominant wildlife groups associated with the environmental restoration project areas. The WYNDD has tracked 25 species that occur in the vicinity of Jackson; 22 may use habitats near the environmental restoration project areas (table 6-4, Corps 1994). Five of these species are Federally listed as threatened or endangered and are discussed in paragraph 6.3.2.6. Most of the remainder are considered extremely rare (less than 5 occurrences) to rare (21 to 100 occurrences) in Wyoming and are discussed in the following paragraphs. Construction activity needed to conduct environmental restoration work would involve noise from heavy equipment and human presence. The degree of disturbance from these activities on wildlife would depend on timing and location.

The only habitat losses expected for the environmental restoration project areas would be associated with construction activities and would be short-term. These temporary losses would only affect the few wildlife species that use the relatively disturbed habitats currently associated with the levees and access roads.

Wildlife in the construction area would be disturbed by the environmental restoration work. Wildlife respond to disturbance either by avoidance or habituation. Short-term disturbance (such as that associated with the environmental restoration work) would probably cause temporary avoidance that may disrupt foraging/migration patterns or traditional use for a single season but would have no long-term effects. However, long-term disturbance might cause wildlife to avoid otherwise suitable habitat, effectively resulting in additional habitat loss. Species that cannot avoid disturbance, such as small mammals, may become habituated.

Since construction would occur during the day, mammals that are mobile and diurnal or nocturnal would be relatively unaffected by the associated disturbance. Some species may temporarily relocate bedding areas.

See table 6-5 for the Priority I, II, and III Wyoming Species as of 1997 (Deibert, P. pers. comm.). The lists are prioritized for the species of concern and the habitats that these species use. Habitats include stream class (Class 1 is a blue-ribbon trout stream) and big game critical range/parturition areas.

These species and ranges are valued from irreplaceable to high value within the WGFD. These species are not listed on the Federal list but are mentioned because of their local importance.

Figure 6-2. Summary of PSS Vegetation Projections.

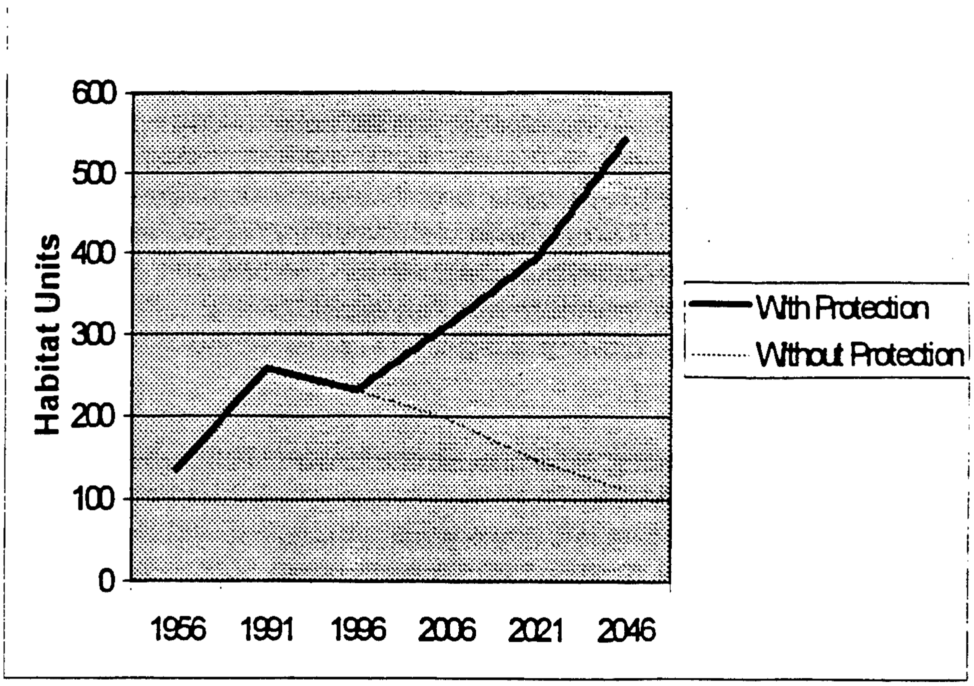


Figure 6-3. Summary of PF Vegetation Projections.

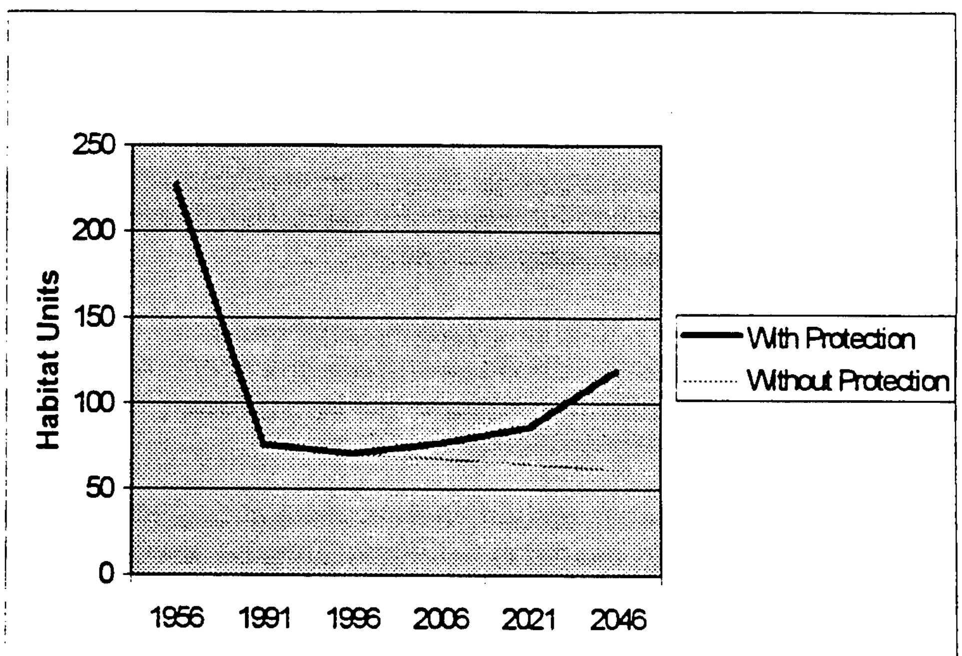


Table 6-3. Partial list of Plant Species Identified by the WYNDD that may Occur Near the Environmental Restoration Project Areas.[1/]

Common Name	Scientific Name	Federal Status[2/]	WY List & Rank[3/]	Habitat[4/]
Oak fern	*Gymnocarpium dryopteris*		2, S1	Moist banks of creeks; moist woods; and wetland/seep areas in spruce/subalpine fir forests on talus.
Steer's head	*Dicentra uniflora*		2, S2	Forest clearings; open slopes with sparse vegetation; rocky soils; sagebrush communities; and disturbed sites.
Boreal draba	*Draba borealis*	USFS	1, S1	Moist soils along streams and on shaded north-facing slopes; calcareous substrate/talus.
Marsh cinquefoil	*Potentilla palustris*		S2	Wetlands; moist places.
Railhead milkvetch	*Astragalus terminalis*		2, S1	Sagebrush grasslands on westerly slopes; river bottoms.
Nuttall townsend-daisy	*Townsendii nutalli*		3, S3	Sandy open areas.
Southern naiad	*Najas guadalupensis*		S1	Warm ponds.
Nodding fescue	*Festuca subulata*		S2	Wet thickets; moist to dry woods; meadows.
Frie's pondweed	*Potamogeton friesii*		S1	Shallow water.
Blunt-leaf pondweed	*Potamogeton obtusifolius*		2, S1	2 to 4 feet of water over soft, mucky bottoms.
Buxbaum's sedge	*Carex buxbaumii*		2, S2	Along shorelines; wet meadows next to lakes.
Fernald alkali grass	*Puccinella fernaldii*		2, S1	Willow thickets, usually in water.
Pale duckweed	*Lemna valdiviana*		2, S1	Warm ponds.
Giant helleborne	*Epipactis gigantea*	USFS	1, S1	Moist meadows in vicinity of calcareous ponds; streambanks; lake margins; and near springs.
Broad-leaved twayblade	*Listera convallariodes*	USFS	2, S1	Grassy areas under aspen-alder.

[1/] Species from the WYNDD were excluded from the list if they are generally restricted to habitat types (*i.e.*, alpine talus and wet limestone cliffs) that do not occur near work areas.

[2/] Federal Status: C2 - Category 2 candidate for Federal listing as threatened or endangered. Current data insufficient to support listing.
USFS - Species is considered sensitive by the USFS.

[3/] State List: List 1 (Highest Priority) - Includes the following: (1) Federally listed and proposed threatened and endangered species and category 1 and 2 candidates for listing (except where current data indicate such status is inappropriate); (2) species designated sensitive on Federal lands or that are being recommended for sensitive designation by the WYNDD; and (3) other species that are quite rare and/or threatened globally or regionally but that have no formal protection status. List 2 (Medium Priority) - Includes the following: (1) species on designated Watch Lists for Federal lands or that are being recommended for Watch Lists by WYNDD, and (2) other species that are moderately rare and/or somewhat threatened globally or regionally. List 3 (Lowest Priority) - Includes the following: (1) species previously considered high or medium priority, but downranked as new information became available, or (2) species that are rare in Wyoming, but common and secure in adjacent areas.

State Rank: S1 - critically imperiled in the state because of extreme rarity or vulnerability to extirpation (5 or fewer occurrences); S2 - imperiled in the state because of rarity or vulnerability to extinction (6 to 20 occurrences); S3 - rare or uncommon in the state (21 to 100 occurrences).

[4/]Habitat: As described in the WYNDD and Hitchcock and Cronquist 1981.

Table 6-4. Partial List of Wildlife Species Identified by the WYNDD that may Occur Near Environmental Restoration Project Areas.[1]

Common Name	Scientific Name	Federal Status[2]	WY List & Rank[3]	Mgmt. Status[4]	Habitat[5]
Boreal western toad	*Bufo boreas boreas*	C2	S2		Wide variety of habitats-streams, woodlands, meadows.
Spotted frog	*Rana pretiosa*	C2	S3	S-USFS	Near permanent water.
Northern leopard frog	*Rana popiens*		S3S4		Wide variety of habitats.
Common loon	*Gavia immer*		S2BS4N	I-WGFD S-USFS	Lakes.
Trumpeter swan	*Cygnus buccinator*	C2	S1S2BS2N	I-WGFD S-USFS	Lakes, rivers.
Harlequin duck	*Histrionicus histrionicus*	C2	S2BS2N	S-USFS	Swift streams.
Osprey	*Pandion haliaetus*		S3S4BS4N		Along rivers/streams/lakes.
Bald eagle	*Haliaeetus leucocephalus*	LE	S1BS2N		Primarily along rivers and other waterbodies.
Northern goshawk	*Accipiter gentilis*	C2	S4BSZN		Conifer forests; hunts in open areas.
Merlin	*Falco columbarius*		S2S3BSZN	II-WGFD	Open forests and a variety of habitats.
Peregrine falcon	*Falco peregrinus anatum*	LE	S1BS1N		Open wetlands near cliffs.
Whooping crane	*Grus americana*	LE	SHBS1N		Freshwater marshes.
Long-billed curlew	*Numenius americanus*	3C	S3BS4N	III-WGFD	Wet and dry grasslands.
Flammulated owl	*Otis flammeolus*		S1BSZN	S-USFS	Woodlands.
Great gray owl	*Strix nebulosa*		S2B2N	S-USFS	Dense conifer forest; hunts in open wet areas.
Silver-haired bat	*Lasionysteris noctivagans*		S3		Dense conifer forest; hunts in open areas.
Hoary bat	*Lasiurus cinerus*		S3	III-WGFD	Dense conifer forest; hunts in wet open areas.
Long-eared myotis	*Myotis evotis*		S5		Dense conifer/mixed forests; hunts in forests and near water, wetlands.
Gray wolf	*Canis lupus*	LE	SH		Wide variety of habitats.
Grizzly bear	*Ursus arctos*	LT	S1S2		Wide ranging-almost all habitat types.
River otter	*Lutra canadensis*		S3	III-WGFD	Rivers and streams.
American bison	*Bison bison*		S4		Grasslands, open areas.

[1] Species from the WYNDD were excluded from the list if they are generally restricted to habitat types (*i.e.*, alpine talus and wet limestone cliffs) that do not occur in the vicinity of a potential quarry or access/crossing sites.

[2] Federal Status: LE - listed endangered; LT - listed threatened; C2 - Category 2 candidate for Federal listing as threatened or endangered. Current data insufficient to support listing; and 3C - once considered for listing as endangered or threatened but no longer receive such consideration.

[3] State Rank: S1 - critically imperiled in the state because of extreme rarity or vulnerability to extirpation (5 or fewer occurrences); S2 - imperiled in the state because of rarity or vulnerability to extinction (6 to 20 occurrences); S3 - rare or uncommon in the state (21 to 100 occurrences); S4 - apparently secure in the state (many occurrences); S5 - demonstrably secure in the state. For migratory birds, each of these categories is assigned to breeding status (B) and migratory status (N); SZN - species are not of significant concern when migrating through Wyoming; and SHB - historical breeder. State ranks may fall between 2 categories (*i.e.*, S1S2B).

[4] Management Status: I-WGFD (Priority I) - includes federally listed endangered and threatened wildlife as well as species in need of immediate attention and active management to ensure that extirpation or a significant decline in population does not occur; II WGFD (Priority II) - species that are in need of additional study to determine whether intensive management is warranted; III WGFD (Priority III) - species whose needs should be accommodated in resource management planning but do not need intensive management; S-USFS - species is listed as sensitive by the USFS in Region 4 (includes the Bridger-Teton National Forest).

[5] Habitat: As described in the WYNDD; Stebbins 1985; National Geographic Society 1987; Brown 1985.

Table 6-5. Priority I, II, and III Wyoming Species as of 1997.

Priority I Species Wyoming (which could occur in study area):

American white pelican (*Pelicanus erythrorhynchos*)
Trumpeter swan (*Cygnus buccinator)*
Black crowned night heron (*Nycticorax nycticorax*)
Common loon (*Gavia immer)*
White-faced ibis (*Plegadis chihi*)
Snowy egret (*Egretta thula*)
Caspian tern (*Sterna caspia*)
Forster's tern (*Sterna forsteri*)

Priority II Species Wyoming (which could occur in study area):

Clark's grebe (*Aechmophorus clarkii*)
Western grebe (*Aechmophorus occidentalis*)
American bittern (*Botaurus lentiginosus*)
Merlin (*Falco columbarius)*
Upland sandpiper (*Bartramia longicauda*)
Black tern (*Chidonias niger*)
Burrowing owl (*Athene cunicularia*)

Priority III Species Wyoming (which could occur in study area):

Long-billed curlew (*Numenius americanus)*
Great blue heron (*Ardea herodias*)
Ferruginous hawk (*Buteo regalis*)
Black-backed woodpecker (*Picoides arctus*)
Masked (Preble's) shrew (*Sorex cinereus*)
Merriam's shrew (*Sorex merriami*)
Hoary bat (*Lasiurus cinerus)*
Wolverine (*Gulo gulo*)
River otter (*Lutra canadensis)*
Lynx (*Felis lynx*)

Other species not listed above:

Loggerhead shrike (*Lanius ludovicianus*)
Goshawk (*Accipiter gentilis)*
Spotted frog *(Rana pretiosa)*
Harlequin duck (*Histrionicus histrionicus)*
Elk (*Cervus elaphus nelson*)
Moose (*Alces alces shirasi*)
Mule deer (*Odocoileus hemionus hemionus*)
Bighorn sheep (*Ovis canadensis canadensis*)

6.3.2.1 Mammals

Elk (*Cervus elaphus nelson*), mule deer (*Odocoileus hemionus hemionus*), Shiras moose (*Alces alces shirasi*), bighorn sheep (*Ovis canadensis canadensis*), and American bison (*Bison bison*) are the most prominent wildlife in the Jackson Hole, Wyoming, area. Aquatic furbearers, black bear (*Ursus americanus cinnamomum*), coyote (*Canis latrans*), and a variety of small and medium-sized mammals also occur.

6.3.2.2 Big Game

Big game concerns focus on usage patterns within the region of Jackson Hole, Wyoming. Important winter feeding areas are located near the work area and migration patterns to and from these feeding areas go through the Snake River drainage. The usage patterns include spring-summer-fall range, winter range, winter/year-long range, critical winter range, and critical winter/year-long range (Corps 1990). The local mule deer, elk, moose, and bighorn sheep herds represent these types of usage. The critical range areas are the areas of greatest concern. Most conflicts would be avoided with the time restrictions imposed by river flows. If heavy excavations (gravel removal and sorting) are performed early in the work window and work takes place during daylight hours, conflicts would be minimized even further. It is recommended by the WGFD to cease work by November 15. Depending on the year, there may be opportunities to extend the work window into December or beyond if WGFD biologists are consulted and conditions warrant an extension.

The Jackson Hole, Wyoming, area has one of the largest populations of elk in North America. Jackson Hole and the surrounding mountains provide about 1,000 square miles of summer range for approximately 15,000 elk. During the winter, the populations concentrate in much smaller areas. The National Elk Refuge just northeast of Jackson, Wyoming, provides about 24,000 acres of winter habitat for 10,000 elk. The refuge includes winter range and a supplemental feeding area for elk (Corps 1994). The WGFD classifies this refuge as a crucial winter range, which is defined as one that determines whether the elk population in the area reproduces and maintains itself at or above WGFD target levels. In addition to the refuge, there are several other smaller wintering areas used by elk in the upper Snake River drainage (Corps 1994).

The Jackson Hole, Wyoming, area provides habitat for mule deer throughout the year. Mule deer use the area primarily for migration. The Sublette herd winters in the Green River Basin to the east. A small herd of mule deer winter in the South Park Elk Feed Grounds area (Corps 1990).

The upper Snake River drainage provides year-round habitat for about 200 to 300 moose. During the winter, an additional 400 to 500 moose from the surrounding uplands migrate into the river bottom area (Corps 1994). Winter densities range

from 4.3 moose per mile between the South Park and Wilson Bridges to 6 moose per mile between Wilson Bridge and the confluence of the Gros Ventre River (Corps 1994).

Bighorn sheep are present seasonally in all major drainages within the Snake River and Gros Ventre River Basins (Corps 1994). The Gros Ventre drainage contains the primary wintering area for bighorn sheep that summer in the Gros Ventre Wilderness. In addition, a major wintering area occurs at Camp Davis. approximately 4 miles southeast of the confluence of the Hoback River. Sheep use steep slopes and breaks along the Snake and Hoback Rivers year-round. Brush and grassland areas at high elevations, within these drainages, are the primary feeding areas for bighorn sheep (Corps 1994). The following are big game usage for the specific environmental restoration project areas:

Area 1

This area has been designated as a critical moose (Sublette unit) wintering/year-long area. Deer, elk, bighorn sheep, and moose migrate through the area from side canyons. Elk from the Fall Creek unit migrate to reach the state feeding grounds located downstream of this site. Elk use the area primarily for winter range. Bighorn sheep of both the Targhee and Jackson units and mule deer of the Sublette unit use the area primarily as spring, summer, and fall range. Since most work would be conducted in late summer and early fall, conflicts with the winter migration should be minimal. If weather conditions are such that big game migrate early, then conditions (deep snow) would be such that construction activities would be halted. To avoid conflicts with migrating big game, work should cease by November 15, unless prior coordination with WGFD has taken place.

Area 4

This area is critical moose (Sublette unit) wintering/year-long use area. Deer, elk, bighorn sheep, and moose migrate through the area from side canyons. Elk from the Fall Creek unit migrate to reach the state feeding grounds located downstream of this site. Elk use the area primarily as winter range. Bighorn sheep of the Targhee unit and mule deer from the Sublette unit use the area for spring, summer, and fall range. Since most work will be conducted in late summer and early fall, conflicts with the winter migration should be minimal. If weather conditions are such that big game migrate early, then conditions (deep snow) may be such that construction activities would be halted. To avoid conflicts with migrating big game, work should cease by November 15, unless prior coordination with WGFD has taken place.

Area 9

This area is critical moose (Jackson unit) wintering/year-long use area. Deer, elk, bighorn sheep, and moose migrate through the area from side canyons. Elk of the

Jackson unit use the area primarily for migration. Bighorn sheep of the Targhee unit and mule deer from the Jackson unit use the area for spring, summer, and fall range. Since most work would be conducted in late summer and early fall, conflicts with the winter migration should be minimal. If weather conditions are such that big game migrate early, then conditions (deep snow) may be such that construction activities would be halted. To avoid conflicts with migrating big game, work should cease by November 15, unless prior coordination with WGFD has taken place.

Area 10

This area is critical moose (Jackson unit) wintering/year-long use area. Deer, elk, bighorn sheep, and moose migrate through the area from side canyons. Elk of the Jackson unit use the area primarily for migration. Bighorn sheep of the Targhee unit and mule deer from the Jackson unit use the area for spring, summer, and fall range. Mule deer from the Jackson Hole unit also use the area as critical winter range. Since most work would be conducted in late summer and early fall, conflicts with the winter migration should be minimal. If weather conditions are such that big game migrate early, then conditions (deep snow) may be such that construction activities would be halted. To avoid conflicts with migrating big game, work should cease by November 15, unless prior coordination with WGFD has taken place.

6.3.2.3 Other Mammals

Shrews (*Sorex* spp.) and voles (*Microtus* spp.) are common in riparian areas along the Snake River and its tributaries and would be expected to inhabit the environmental restoration project areas. Aquatic furbearers such as beaver (*Castor canadensis*), mink (*Mustella frenata*), and muskrat (*Ondatra zibethicus*) are commonly seen in streams, ponds, and backwater areas along the Snake River near Jackson, Wyoming. The levees are generally too rocky or exposed to provide habitat for either the beaver or muskrat. Beaver frequently construct dams in the Jackson Hole area (Corps 1994).

There are four mammal species (excluding Federally listed or candidate species) occurring in the Jackson Hole area that are tracked by the WYNDD table 6-4. The river otter (*Lutra canadensis*), a species considered rare in Wyoming, has been documented by the WYNDD. This species has been observed along the Snake River near logjams, pools, and oxbows that concentrate fish (Corps 1994). The hoary bat (*Lacers cinerus*), also considered rare in Wyoming, has been reported in the Jackson Hole area. Two other rare species, including the silver-haired bat (*Lasionycteris noctivagans*) and long-eared myotis (*Myotis evotis*), have been documented by the WYNDD in the Jackson Hole area. Wolverine (*Gulo gulo*) and lynx (*Felis lynx*) are also rare and occur in the region.

Small- and medium-sized mammals would be affected by disturbances associated with construction at environmental restoration project areas. Many of these species

would avoid areas subject to disturbance; others would habituate. The river otter would likely temporarily avoid the environmental restoration project areas during construction but would not experience any long-term effects from disturbance.

6.3.2.4 Birds

The upper Snake River drainage provides habitat for a wide variety of resident and migratory birds, including waterfowl, raptors, and passerines. Approximately 150 different species have been observed, and 119 are documented or expected to breed in the area (Corps 1994).

The Corps would schedule construction activities at the environmental restoration project areas, which have critical waterfowl brood-rearing habitat, after nesting season to avoid impacts to nesting waterfowl and other birds. Construction at these sites would be scheduled after August 1 or 15 if bald eagle constraints apply (see paragraph 6.3.2.6.1). Resident birds and migrants (including several species considered rare in Wyoming) would be expected to temporarily avoid foraging or staging in areas subject to disturbance. No impacts to wintering birds, including the trumpeter swan, would be expected because construction activities for restoration would not occur at this time.

6.3.2.4.1 Waterfowl and Water Birds

The wetlands, ponds, backwater, and tributary creeks in the Snake River floodplain provide habitat for waterfowl and waterbird spring/fall staging, breeding, nesting, brood rearing, and wintering. The most prominent include Canada geese (*Branta canadensis*), trumpeter swans (*Cygnus buccinator*), and sandhill cranes (*Grus canadensis*); but common mergansers (*Mergus merganser*), mallards (*Anas platyrhynchos*), buffleheads (*Bucephala albeola*), and Barrow's goldeneyes (*B. islandica*) are also common seasonally. Frequently observed waterbirds include the American white pelican (*Pelecanus erythrorhynchos*), great blue heron (*Ardea herodias*), black-crowned night heron (*Nycticorax nycticorax*), western grebe (*Aechmophorus occidentalis*), and cormorant (*Phalacrocorax auritus*). Rarer migrants would include American bittern (*Botaurus lentiginosus*), black tern (*Chidonias niger*), Caspian tern (*Sterna caspia*) and Forster's tern (*Sterna forsteri*), white-faced ibis (*Plegadis chihi*), Clark's grebe (*Aechmophorus clarkii*), and snowy egret (*Egretta thula*). Long-billed curlew (*Numenius americanus*) and upland sandpiper (*Bartramia longicauda*) would be associated with the upland shrub-steppe habitat. They may be found along the river corridor foraging during migration.

Of the species listed above, only two would have a high potential for nesting/living in the work area: the black-crowned night heron and great blue heron. The ibis and snowy egret may be seen in wetland areas outside of the levee system during migration. Western and Clark's grebes would be associated with the lakes and ponds in the region. The other species listed could live in the forest/woodlands adjacent to the river or migrate through the riverine system. Because work would be

restricted to outside of the nesting season and removal of existing trees and shrubs would be avoided wherever possible, impacts to these species should be minimal or nonexistent.

On average (1982 through 1987), approximately 1,320 dabbling and 666 diving ducks winter on the river between Moose Junction and South Park (Corps 1994). Between Wilson and South Park Bridges, winter duck densities frequently average 139 per mile of river and tributary. This area is considered crucial winter waterfowl habitat (Corps 1994). Much of this same area is also considered crucial brood-rearing habitat (Corps 1994).

The harlequin duck (*Histrionicus histrionicus*), a candidate for Federal listing as threatened or endangered, is a species considered very rare in Wyoming and has been documented by the WYNDD in the Jackson Hole area (table 6-4). The common loon (*Gavin immer*), also rare in Wyoming and intensively managed, has been reported in the Jackson Hole area.

About 42 breeding pairs of Canada geese use the Snake River between the confluence of the Gros Ventre River and South Park Bridge. These consist of 22 pairs north of the Wilson Bridge and 20 pairs to the south (Corps 1994). The most important goose nesting areas include the confluence of the Gros Ventre River, the confluence of Blue Crane Creek, and between the confluence of the Spring Fork of Fish Creek and the confluence of Spring Fork of Spring Creek (Corps 1994). Stable islands with trees and logs that provide the cover necessary to reduce nesting losses from avian predation characterize these areas (Corps 1994). Areas 1, 4, and 10 are located near these nesting sites.

Brood-rearing habitat for Canada geese along the Snake River includes grazed meadows, ponds, gravel pits, and islands. The most important brood-rearing habitat is found in the following locations: (1) in wet meadows on the National Elk Refuge; (2) along the east side of the Snake River from the confluence of the Gros Ventre River to the Wilson Bridge; (3) the Snake River between Wilson and South Park Bridges; (4) the area between Fish Creek and the Snake River south of the landing strip; (5) South Park; and (6) about 2 miles of Flat Creek upstream from its confluence (Corps 1994). All environmental restoration project areas are within Canada goose brood-rearing habitat.

Between 1982 and 1988, the upper Snake River supported an average of 390 wintering Canada geese (Corps 1994). Wintering habitat is often limited by the lack of ice-free water. Crucial winter habitat includes: (1) nearly all of the river between the Wilson and South Park Bridges; (2) about half of the South Park area; (3) the area between Fish Creek and the Snake River south of the landing strip; and (4) about 2 miles of Flat Creek upstream from its confluence (Corps 1994). Other wintering areas include the river upstream of Wilson Bridge and two small off-river areas north of the bridge (Corps 1994). All of the environmental restoration project sites are within crucial Canada goose winter habitat.

The trumpeter swan is a candidate for Federal listing as threatened or endangered and is considered extremely rare in Wyoming. This species is intensively managed by the WGFD and is designated as sensitive by the USFS in the Jackson Hole area (table 6-4). In 1988, a total of 98 trumpeter swans wintered in the Jackson Valley. Grand Teton National Park, and the National Elk Refuge (Corps 1994). Trumpeter swan winter habitat in Wyoming, Idaho, and Montana appears to have the following characteristics (Corps 1994):

- soft substrate less than 2 inches deep;
- water less than 4 feet deep;
- channel greater than 50 feet wide;
- banks with no trees or shrubs;
- loafing sites with water less than 4 inches deep or sand/gravel bars in or near feeding areas;
- no physical barriers that bisect feeding or loafing areas or travel corridors;
- shallow water containing beds of diverse aquatic macrophytes that are available for at least 75 percent of the winter and not iced over for more than 2 or 3 days at a time; and
- water velocity in feeding areas that does not exceed 1 1/2 feet per second.

The Snake River, from the start of the Right Bank Federal Levee to just south of the Wilson Bridge, is considered potential wintering habitat for the trumpeter swan (Corps 1994). The river in this area is less than optimal for wintering swans because of the lack of calm water and absence of aquatic vegetation. Crucial winter habitat for trumpeter swans is provided by the following areas: (1) the Snake River downstream of the Wilson Bridge; (2) about half of the South Park area; (3) the area between Fish Creek and the Snake River south of the landing strip; and (4) about 1 mile of Flat Creek upstream from its confluence (Corps 1994). The Fish Creek, South Park area, and lower Flat Creek wintering areas received about 5,951 swan use days per year between 1982 and 1986 and 7 to 14 breeding pairs rely on these areas annually (Corps 1994). Fish Creek is the most heavily used of these areas and Flat Creek the least. Environmental restoration project Areas 1 and 4 south of Wilson Bridge are within crucial winter habitat for the trumpeter swan (Corps 1994).

There are several nesting pairs of trumpeter swans in the Jackson Hole area and there are at least three specific areas that are important for brood rearing (Corps 1994). None of the environmental restoration project areas are near trumpeter swan nests or brood-rearing locations.

Sandhill cranes nest in the upper Snake River drainage, primarily in beaver ponds and seasonally flooded emergent wetlands. This area supports between four and eight pairs of nesting cranes annually, but none are near the environmental restoration project areas (Corps 1994).

During spring migration, about 30- to 100-sandhill cranes use the meadows between South Park area and Spring Creek (Corps 1994). Area 1 is the only work site near this staging area.

The proposed work has the potential to impact some of these species. The timing of the work would minimize these impacts since breeding season will be coming to an end. Care will be needed to avoid impacting water birds, especially at Areas 1 and 4. Most of the birds would avoid the construction zones. Workers should take care not to injure or unduly harass water birds that may be found during construction activities.

6.3.2.4.2 Raptors

The upper Snake River and associated habitats support high numbers of fish and small mammals that provide prey for a variety of raptors. The most commonly observed raptors are the osprey (*Pandion haliaetus*), red-tailed hawk (*Buteo jamaicensis*), Swainson's hawk (B. *swainsonii*), and American kestrel (*Falco sparverius*). Other raptors known to occur in this area include ferruginous hawks (*Buteo regalis*), golden eagles (*Aquila chrysaetos*), western screech owls (*Otis kennicotii*), great horned owls (*Bubo virginianus*), and short-eared owls (*Asio flammeus*) (Corps 1994). Rarer hawks include the goshawk (*Accipiter gentilis*) and merlin (*Falco columbarius*). Most of these raptors nest in trees behind the levees.

Annually, three to four pairs of osprey nest along the Snake River in the Jackson Hole area, usually in partially or completely dead standing trees or artificial structures (Corps 1994). Approximately seven osprey nest sites have been documented along the Snake River between the beginning of the Left Bank Federal Levee and South Park Bridge (Corps 1994). All of the environmental restoration project areas are in the vicinity of these osprey nest sites. The osprey is considered rare or uncommon in Wyoming (table 6-4).

Two owl species tracked by the WYNDD (excluding Federally listed or candidate species) occur in the Jackson Hole area (table 6-4; Corps 1994). The flammulated owl (*Otis fammeolus*), considered extremely rare, and great gray owl (*Strix nebulosa*), considered very rare in Wyoming, have been seen in the vicinity of the Snake River downstream of the environmental restoration project areas.

Burrowing owls (*Athene cunicularia*) are found in the Wyoming. They migrate to the state primarily for breeding. They are associated primarily with prairie dog towns but will nest in the burrows of other mammals. It is highly unlikely that burrowing owls use the Jackson Hole area because of the lack of prairie dog towns and the short warm season. This type of habitat would not be found in the Snake River corridor so the environmental restoration work would not affect this species.

Raptors would avoid construction activities until they habituate to it. Workers should take care not to unduly harass raptors that might be found during work activities.

Removal of existing vegetation should be avoided wherever possible. Bald eagles are discussed in paragraph 6.3.2.6.

6.3.2.4.3 Other Birds

Other birds known to commonly occur in the Snake River floodplain near the Jackson Hole area include the loggerhead shrike (*Lanius ludovicianus*), black-backed woodpecker (*Picoides arctus*), killdeer (*Charadrius vociferus*), tree swallow (*Tachycineta bicolor*), yellow-headed blackbird (*Xanthocephalus xanthocephalus*), common nighthawk (*Chordeiles minor*), belted kingfisher (*Ceryle alcyon*), and Wilson's warbler (*Wilsonia pusilla*) (Corps 1994). These species and others would be expected to occur in the vicinity of the environmental restoration project areas. These species would face the same impacts as water birds and raptors.

6.3.2.5 Reptiles and Amphibians

Relatively little is known about amphibians and reptiles in the Jackson Hole area. Two frog species, the spotted frog (*Ranu pretiosa*), and northern leopard frog (*Ranu pipiens*); and one toad species, the boreal western toad (*Bufo bufo boreas*), considered very rare or rare in Wyoming, have been documented in the vicinity of the environmental restoration project areas (table 6-4). The sagebrush lizard (*Sceloporus graciosus*) and western terrestrial garter snake (*Thamnophis elegans*) are probably two of the most common reptiles in the area. The existing riparian vegetation within or near the environmental restoration work could have these species present. These species would be impacted if present within the side channels when construction activities are taking place. Most reptiles and amphibians would move from the area, but a few individuals may be injured or killed inadvertently. The timing of the work in late summer and fall would reduce these impacts.

6.3.2.6 Threatened and Endangered Species

The USFWS has documented five species in the Jackson Hole area that are classified as threatened or endangered. Endangered species observed in this area include the bald eagle (*Haliaeetus leucocephalus*), whooping crane (*Grus americana*), and peregrine falcon (*Falco peregrinus*). The Jackson Hole area is also within historical range for the grizzly bear (*Ursus arctos horribilis*), a threatened species, and gray wolf (*Canis lupus*), an endangered species (Corps 1994).

6.3.2.6.1 Bald Eagle

The upper Snake River drainage provides year-round habitat for bald eagles. Nesting usually occurs between February 1 and August 15. The Snake River population unit, which includes the Snake River in Wyoming, its tributaries, and Jackson Lake, consisted of 24 known breeding pairs in 1982 (Corps 1994). In 1992, seven active bald eagle nest sites existed between Moose and South Park Bridge,

including one just downstream of Moose, one near the confluence of the Gros Ventre River, and five between the Wilson and South Park Bridges (Corps 1994). Between 1982 and 1989, the productivity of bald eagles nesting between Moose and the South Park Bridge averaged 1.47 young per nesting attempt. a number considered excellent (Corps 1994).

Bald eagles in the Jackson Hole area feed primarily on fish in the summer and waterfowl and carrion in the winter. Between 5 and 15 bald eagles have been observed during the winter along the Snake River between Moose and the South Park Bridge prior to 1994 (Corps 1994). This entire reach has been designated by WGFD as crucial wintering and nesting habitat (Corps 1994). All of the environmental restoration project areas are contained within this habitat.

In the past in Area 1, a bald eagle nest has been mapped toward the north end of the trees on the east side of the channel. No active nests were located in this area during 1998.

Bald eagles nested near Area 4 in 1998. Two active nests were located on the east side of the river. One nest was located about 2 1/2 to 3 miles south of the Wilson Bridge, 50 yards outside the levee. The second nest was about 1 1/2 miles south of the first nest, 3 to 4 hundred yards outside of the levee. Both nests were on private property.

Bald eagles nested near Area 9 in 1998. The nest was located on the west side of the river, outside of the levee, near human habitation.

Bald eagles nested near Area 10 in 1998. The nest was located in a grove of trees on the north side of the Gros Ventre River near the mouth. Both eagles were spotted during a tour of the area in 1998.

The CAR received from the USFWS (appendix B) stated, "No work activity within 1 mile of any active nests would occur between February 1 and August 15." For this reason, work would only be allowed within 1 mile of active nests (current year) between August 16 and January 31. Changes to this work window must have prior approval from the USFWS. No other constraints have been applied to nesting bald eagles. Since it is still unknown when work will actually commence, the environmental restoration project area would have to be surveyed for bald eagle nest each spring of the year when work is to be performed.

Because of the equipment access restrictions due to river flows, construction and excavation activities should not conflict with nesting. All standing mature trees in the work area would be avoided if at all possible. Trees that are leaning or already on the ground may be moved aside to facilitate excavation and construction. All of the known eagle nesting trees are currently located outside of the levee system. The biologist on site would work with the construction crew to avoid areas where equipment could damage mature trees.

Bald eagles would also be wintering in the area. The biologist on site would monitor for the presence of eagles and provide guidance to the work crews to avoid activities that might disturb the eagles. It is not anticipated that the work activity would cause additional disturbance to the eagles using the area beyond the human disturbance already occurring through normal recreational use.

Bald eagles are likely to be found in or near the work area most of the year. The chances of the environmental restoration project having any impact on the bald eagle are minimal due to the timing of the active work. There would likely be no direct impacts (mortality, loss of nest, *etc.*) or long-term population impacts (reduced reproduction, *etc.*). There may be some minor displacement of foraging or roosting eagles.

6.3.2.6.2 Peregrine Falcon

Until recently, the peregrine falcon was considered extirpated from Wyoming (Corps 1994). A recovery program was begun in 1980. Between 1980 and 1987, 153 peregrine falcons were released to hack sites (the term used for reintroduction sites) in Wyoming, primarily in Yellowstone National Park and in or near the National Elk Refuge. In 1986 and 1987, each year 25 peregrine falcons were released to 5 hack sites in Wyoming. One of these hack sites is located northwest of Wilson and another is on the National Elk Refuge. Approximately 80 to 83 percent of the released birds reached independence (Corps 1994).

The wetlands and streams along the Snake River south of Wilson Bridge support a variety of birds that are prey for peregrine falcons. This area is considered forage habitat for peregrine falcons and three to four adults and sub-adults have been observed in this region between 1982 and 1988 (Corps 1994).

In 1988, 6 nesting pairs of peregrine falcons in Wyoming produced 10 young (Corps 1994). In 1998, two eyries (nest sites) were located in the vicinity of the Grand Teton Mountains. Currently, one peregrine falcon forages in the South Park area near Fish Creek. This area is near the West side of Area 4.

Peregrine falcons are expected to leave the area soon after nesting is complete. The timing of nesting is similar to that of the bald eagle. They could be in the area any time between February and August. The biologist on site would monitor for the presence of peregrine falcons and provide guidance to the contractor to avoid activities that might disturb the peregrine falcons. Since the bulk of the environmental restoration work would occur after nesting season, the chance of the environmental restoration project impacting the foraging of peregrine falcons would be minimal.

6.3.2.6.3 Whooping Crane

The whooping crane is one of the rarest birds in North America. Reintroduction efforts at Gray's Lake National Wildlife Refuge in Idaho have resulted in whooping cranes occupying habitat in western Wyoming since 1977. In 1985, about 26 to 31 whooping cranes in the Gray's Lake population spent the summer in Wyoming. In 1988, only 16 of the Gray's Lake flock were still alive. Whooping cranes are occasionally sighted in the Jackson Hole area, primarily along the Gros Ventre River (Corps 1994).

Whooping cranes do migrate through the area of Jackson Lake during early spring. There is a chance a whooping crane may stop along the river in the Jackson Hole area, especially if sandhill cranes are using the area. The chances of a whooping crane stopping in the work area would be extremely rare. The whooping cranes would be attracted to wetland pastures and not the riverine corridor between the levees. The confluences of Blue Crane and Fish Creeks are the only two areas that might attract cranes. Areas 1 and 4 are within this region of the river. Most of the work would be taking place between August 15 and November 15. For these reasons, the environmental restoration project would have little or no impacts on the whooping crane population.

If a whooping crane is seen during work activities, work would cease. The WGFD and USFWS personnel would be contacted. Work would resume only after USFWS personnel have been consulted on how to proceed.

6.3.2.6.4 Grizzly Bear

The historical range of the grizzly bear once included most of Western North America. Currently, only six areas in the United States, including Yellowstone and Grand Teton National Parks, support self-sustaining grizzly bear populations (Corps 1994).

The grizzly bear is a resident species to the area, primarily north of the Jackson Hole area. Current management in Wyoming by WGFD is to discourage grizzly bears from living in areas of human habitation. The last sighting of grizzly bears in the Jackson Hole area was in 1994. An adult female with three cubs was captured near Area 4 and relocated to an area north of Jackson Hole. The female was attracted to the area because 15 cows, which were killed by lightning, were buried near the site. The biggest concern with this species is attracting them to the Jackson Hole area.

The chances a bear will be seen on site would be very rare, but precautions are needed since late summer/fall is the time of highest bear activity as they search for food in preparation for hibernation. Workers would be directed not to leave food and other garbage on site that may attract bears to the area. Some of these stipulations could include keeping the work site free of food and garbage and storing trash and food in approved containers. If a grizzly bear is seen during work activities, WGFD

and USFWS personnel would be contacted. Since there is only a slight chance of encounters between grizzly bears and humans, the proposed work is unlikely to have an impact on the grizzly bear population.

6.3.2.6.5 Gray Wolf

The gray wolf historically inhabited all habitats in the Northern Hemisphere except tropical rain forests and deserts (Corps 1994). Currently, the largest populations of wolves in the lower 48 states occur in northern Minnesota. Remnant populations are believed to exist in Wyoming, Washington, Idaho, Montana, Michigan, and Wisconsin (Corps 1994). In the summer of 1992, a wolf was sighted in Yellowstone National Park, the first documented observation in over 20 years. Wolves have been sighted this year following the elk herds into the Jackson Hole area (WGFD 1998, USFWS 1998). Up until this year, there had been no sightings of wolves near Jackson, Wyoming. The wolves following the elk are unlikely to go near the town of Jackson. They would likely stay in the hills surrounding the elk refuge. The wolves avoid human activities including the construction work associated with this environmental restoration project. Like the grizzly, an effort should be made to avoid attracting wolves to human habitation. The same guidelines associated with grizzly bear management should be applied to gray wolves. This includes keeping the site clean of food debris and other garbage. If dead animals are found on or near the work site, they should be removed and disposed of properly. If a gray wolf is seen during work activities, WGFD and USFWS personnel would be contacted.

6.4 AIR QUALITY

Air quality in the Jackson Hole area is generally very good due to low population density, distance from major cities, and lack of large industrial sources of air pollution. The most significant sources of atmospheric emissions in the area are prescribed burns and wildfires. The Bridger-Teton National Forest includes areas in which fires are used to enhance wildlife habitat and to dispose of logging residues (personal communication, F. Kingwell, Forest Service, Bridger-Teton National Forest, Jackson, Wyoming, March 10, 1989/Jackson Hole Flood Protection, Levee Access Improvements, Draft Environmental Assessment, November 1994, Corps). There are no major point sources of air pollution in the area. Consequently, the most significant emission sources are forest fires, automobiles, and residential wood-burning stoves (personal communication, B. Daily, Wyoming Department of Environmental Quality (DEQ), Cheyenne, Wyoming, April 7, 1993/Jackson Hole Flood Protection, Levee Access Improvements, Draft Environmental Assessment, November 1994). Based on current information, ambient air quality standards in Jackson are not being exceeded (personal communication, L. Gribovicz, Wyoming DEQ, Lander, Wyoming, September 16, 1998).

The operation of trucks and other equipment that generate emissions would only occur during the brief fall work window. Construction would occur at only one of the environmental restoration project areas per work season; therefore, emissions would

not be generated at all four areas simultaneously. Increases in emissions from equipment operation at any one of the environmental restoration project areas are expected to be minimal, of short duration, and are not expected to result in a detectable level beyond those currently generated in the Jackson Hole area. Based on this, air quality impacts from emissions are expected to be short-term and negligible. Emissions would not result in any long-term, permanent impacts upon air quality.

Trucks traveling on unpaved roadways may generate dust while transporting supplies and materials. Dust may also become airborne from equipment operation on the gravel bars and levees. Virtually all of the unpaved roads are remotely located; therefore, impacts from fugitive dust along the roadways are expected to be minimal. Negligible amounts of dust are expected to be generated from operation of equipment on gravel deposits between the levees. To minimize the potential for fugitive dust, speed limits for operation of equipment on the gravel bars and upon the levees may be necessary. Because the levees are constructed primarily of rock, only minor concentrations of fugitive dust are expected to be generated by the operation of trucks on the levees. Based on the imposition of speed limits for equipment and minimal potential for generation of dust on the levees, impacts from the generation of dust by equipment operation on gravel bars, roads, and levees are expected to be minimal. No long-term, permanent impacts would occur from fugitive dust.

The generation of dust by cobble screening activities is also expected to be negligible or nonexistent due to the moisture content of the material being screened. Recreational users may experience dust when passing through the immediate vicinity of the screening operation; however, the impact would be of short duration. Overall, any air quality impacts that might occur as a result of cobble screening are expected to be negligible and of short duration.

6.5 LAND USE

Land use in Teton County is heavily influenced by landownership patterns. Federal land in the county is used primarily for recreation, wilderness, wildlife management, and forestry. Private land is primarily classified as agricultural, although the use of land for agricultural purposes has diminished over the years (U.S. Bureau of the Census 1989 and Jackson Hole Flood Protection, Levee Access Improvements, Draft Environmental Assessment, November 1994). Over the past few decades, land previously classified as agricultural has been converted to residential and other nonagricultural uses.

The Federal government is the largest landowner (97 percent) in the 4,000 square miles of Teton County. The USFS administers most of the Federal lands in three national forests within the county, which together comprise approximately 77 percent of the land in the county. Of the three national forests, the Bridger-Teton National Forest has approximately 1,096,000 acres, the most in the county. Other Federal

agencies that manage land within Teton County include the National Park Service. which administers Grand Teton National Park (310,000 acres); the USFWS, which manages the National Elk Refuge (approximately 24,000 acres); the Bureau of Reclamation, which manages Jackson Lake Dam; and the Bureau of Land Management (BLM), which manages approximately 9,000 acres. primarily near the Snake River (Jackson Hole Flood Protection, Levee Access Improvements. Draft Environmental Assessment, November 1994).

Lands within the three national forests in the county are managed for timber production, recreation, wildlife habitat, and wilderness. At Grand Teton National Park, land use is conservation and recreation oriented. National Elk Refuge land is maintained as wildlife habitat. The BLM leases land for grazing and manages some land within Teton County for recreation (primarily near the Snake River).

The State of Wyoming owns approximately 10,000 acres in the county as either school trust lands or resource lands. The WGFD manages 2,000 acres of State-owned land primarily as wildlife habitat but allows some camping. State trust lands comprise approximately 8,000 acres in Teton County of which approximately 1,900 acres are leased to the WGFD; 5,000 acres are leased to grazing and agricultural uses; and the remaining acres are not leased (personal communication, D. Force, Wyoming State Land Farm Loan Office, Cheyenne, Wyoming, August 31, 1992, and Jackson Hole Flood Protection, Levee Access Improvements, Draft Environmental Assessment, November 1994).

Private property accounts for approximately 3 percent (75,000 acres) of Teton County. Of the privately owned land, approximately 1,160 acres are contained within the town of Jackson corporate limits. The size of privately-owned parcels varies from small in-city lots to farms and ranches over 2,000 acres.

Privately owned lands in the county are concentrated on the valley floor of Jackson Hole south of Grand Teton National Park, an area approximately 20 miles long and up to 10 miles wide. There are 160 acres of private holdings within the National Elk Refuge (personal communication, M. Hedrick, Refuge Manager, USFWS, Jackson, Wyoming, August 27, 1992/Jackson Hole Flood Protection, Levee Access Improvements, Draft Environmental Assessment, November 1994). There are significant areas of private holdings in Grand Teton National Park. Most of the private lands within Jackson Hole have not been intensively developed, although there has been rural-to-urban land conversion over approximately the past 3 decades. Ranching has declined considerably as an economic activity, but much of the former ranch land remains mainly in agricultural or woodland use. The vast majority of private land in Teton County has been classified as agricultural land in the past and continues to be. In 1954, there were 98 farms in Teton County comprising 72,724 acres. The U.S. Bureau of the Census 1989 reported 110 farms with a total of 72,197 acres within the county in 1987 (Jackson Hole Flood Protection, Levee Access Improvements, Draft Environmental Assessment, November 1994).

This proposed environmental restoration project would occur upon privately owned lands and lands administered by the BLM. Lands would be altered through the removal of gravel and placement of materials to construct the environmental restoration tools. These alterations, however, would not eliminate any current land uses identified above or introduce any new land uses. The local sponsor would obtain real estate instruments, which the sponsor identifies in their real estate report as being necessary for implementation of environmental restoration work on Federal and private lands.

6.6 TRANSPORTATION

Several highway routes provide year-round transportation in the vicinity of the environmental restoration project. The primary route used by north and southbound traffic is U.S. Highway 26. The highway enters the Jackson Hole area from the northeast, continues through the valley and the community of Jackson, Wyoming, and exits the valley to the south. Wyoming State Highway 22 starts on the west side of Jackson, crosses the Snake River at the Wilson Bridge, and continues west over Teton Pass. Wyoming State Highway 390 extends north from its intersection with State Highway 22 near Wilson Bridge and is a primary route used by north and southbound traffic on the west side of the valley. Several secondary roads also provide access in and around the project area. These include, but are not limited to, South Park Loop, Fall Creek Road, and Spring Gultch Road. Various unnamed private roads exist in and around the project area.

Impacts upon transportation would occur as a result of construction of the environmental restoration project and subsequent performance of work to maintain the structures. Both construction and maintenance would require similar measures to implement. However, maintenance would likely involve less effort than actual construction; therefore, potential impacts from maintenance should be less than those of construction activities.

The transport of construction materials and supplies to the four project areas would increase truck traffic on primary highway routes and secondary roads. Trip repetitions for this type of traffic would generally be limited; therefore, any impact upon traffic patterns from this particular truck activity is expected to be minimal.

The ingress and egress of gravel trucks between gravel screening sites and upland disposal areas at existing gravel processing facilities would likely generate the greatest traffic increase on primary and secondary roads. Because the quantity of gravel that may be transported would reasonably vary from site to site and from year to year, establishment of an estimate for the number of repetitions necessary to perform construction and maintenance is difficult. It is reasonable to expect peaks in truck traffic that would add to or create traffic congestion. Conflicts may exist between contractors performing maintenance of the Jackson Hole Flood Control Project and contractors constructing the environmental restoration project. The

Corps would address such conflicts that occur on the Jackson Hole Flood Control Project access roads and levees. The local sponsor would identify any transportation conflicts on public roads and implement traffic control measures (such as flaggers or signage) at locations that experience more than minimal increases in traffic congestion. Operation of loaded trucks on the Jackson Hole Flood Control Project levees and access roads during construction and maintenance would likely cause impacts to the surface of these structures. The Corps would ensure repair of such surface impacts resulting from construction. The local sponsor would be responsible for repairs to the surface resulting from their post-construction maintenance activities. Because surface repairs would be implemented, impacts upon the access roads and levees would be temporary.

Staging areas for fuel and lubricant storage and dispensing would be located outside of the leveed sections of the Snake River. Staging outside the levees would dramatically decrease the potential for unintentional releases of toxic materials into the Snake River. A minimum of one staging area would be necessary at each of the four work areas. Staging areas would be selected and any easements, licenses, or permits necessary for staging areas would be acquired by the local sponsor. The contractor and any subcontractors would be required to submit for approval, prior to initiation of construction, a hazardous materials spill and cleanup plan including tools and materials that would be on hand and readily available to facilitate containment and cleanup. All overnight equipment storage, as well as refueling and maintenance activities, would be restricted to staging areas. Based upon the above measures, no more than minimal, short-term impacts upon transportation are expected from either maintenance or construction of the environmental restoration project.

Access to work areas would occur primarily upon the roadways identified below, in addition to other unnamed roadways. Access would generally originate from public roadways and may use roadways already under easement for access to the levees for the purpose of performing operation and maintenance activities. Real estate instruments necessary for access will be identified in the local sponsor's real estate report. The local sponsor would coordinate acquisition of necessary real estate instruments.

The roads for the levee access easements are typically dirt roads and are suitable for moving construction equipment. Flows in the Snake River are too high to allow for construction access from only one side of the river so access from both sides of the river would be necessary. The contractor would coordinate with the Corps' biologist, representative for the flood control project, and the landowner (in the field) to determine the optimum access routes for minimizing disturbances. The east and west access points for each of the 4 areas is described below.

6.6.1 Area 1 East Access

The east portion of Area 1 would be accessed from the north from South Park Loop along a 1-mile stretch of gravel road to the Lower Imenson Levee. Once on the levee, construction equipment would follow the levee until it terminates. After the levee ends, access would continue through existing shrubs and trees and over gravel bars.

6.6.2 Area 1 West Access

The west portion of Area 1 would be accessed from Fall Creek Road and involves two different access points. The first access point is for the downstream work area. The access originates off of Fall Creek Road and follows a dirt road to the Sewell Levee. It would then continue along the Sewell Levee to the work area. The access to the upstream work area would also originate from Fall Creek Road and would follow a dirt road to the work area.

6.6.3 Area 4 East Access

The east portion of Area 4 would be accessed from the Federal Levee Extension. Construction equipment would leave the public highway, approximately 4 miles to the north and follow the left bank of the Federal Levee Extension to the work area.

6.6.4 Area 4 West Access

Access to Area 4 would be from Fall Creek Road along an existing gravel road. This access crosses an existing bridge and terminates at the channel bottom. The contractor may need to navigate across gravel bars and around existing vegetation.

6.6.5 Area 9 East Access

Access to the east portion of Area 9 would be from State Highway 22, which provides access to the Left Bank Federal Levee. From the Left Bank Federal Levee, an access point to the specific work areas would be selected in the field.

6.6.6 Area 9 West Access

Area 9 is the most accessible of the four areas. Access for the west portion of Area 9 would originate from State Highway 390. From State Highway 390, the contractors would follow an existing dirt road to the Right Bank Federal Levee.

6.6.7 Area 10 East Access

The work on the east portion of Area 10 would be reached from the downstream direction or the upstream direction. From the downstream direction, equipment would travel from State Highway 22 and then up the Left Bank Federal Levee for

approximately 3 miles to the work areas. From the upstream direction, equipment would travel from Cattleman's Bridge, which is approximately 2 miles away, to the Hanson Levee. The spur dikes located to the north would be accessed from Spring Gultch Road, which is about 2 miles away.

6.6.8 Area 10 West Access

Most of the work in Area 10 lies to the west of the river and would be accessed via the Right Bank Federal Levee. From the levee, construction equipment would traverse existing gravel bars and around or through vegetated areas to the specific work areas. Equipment could reach the levee from both the upstream and downstream directions. The downstream end of the levee would be accessed from a dirt road that runs for about three-fourths of a mile from State Highway 390 to the Right Bank Federal Levee.

6.7 SOCIO-ECONOMICS

The Snake River and its tributaries have been an important resource in the economic and social development of the Jackson Hole area. A study of the economic importance of fishing to Jackson Hole is in effect a study of two of the states most outstanding resources: (1) the Snake River and its system of associated smaller rivers and creeks, and (2) the cutthroat trout. The decision to "go fishing" creates demands for goods and services.

The Jackson Hole area has become the summer home and vacation home destination for a number of families since 1970. Expenditures by these families in the Jackson Hole area, like tourist expenditures, represent a new demand for goods and services and a flow of new money into the local economy.

A Chamber of Commerce study (1985) was targeted at tourists visiting the area regardless of whether the party was from out-of-state or from another county in Wyoming. The results of this study indicated that the direct fishing related expenditures of $6,967,000 brought nearly $61,000,000 of "new money" into the area. The $61,000,000 total output relates to the direct, indirect (related industry output), and induced spending (household spending generated from the direct and indirect industry spending). This concept is called the "multiplier effect." The multiplier in this case is 8.9. This means that every dollar of direct spending generates $8.90 of total output throughout the local economy. Examples of related output may be local motel, eating establishments, and any other incidental expenditures the nonlocal may make while recreating and fishing in the area.

Translating these 1985 base numbers into current 1998 price levels using local inflation rate of 6.8 percent per year yields the following results. Direct fishing related expenditures at 1998 price levels are expected to be $16,386,000 [1985-1998 = 13 years @ 6.8 percent per year inflation (includes both money inflation of

4.05 percent and population growth of 2.7 percent) with gross receipts of $143,300,000 in local related industries].

The Jackson Hole, Wyoming, Environmental Restoration Project. studies four sites along the Snake River that are expected to yield the most benefit to the riparian and aquatic habitat. Assuming all four site alternatives are implemented and comparing the resulting benefits in aquatic and riparian habitat units, the Corps speculates that over the 50-year project period average annual fish numbers (cutthroat trout and other species) will help maintain their present population. Without the environmental restoration project, aquatic and riparian habitat will be expected to decline over the next 50 years.

The environmental restoration project, by improving the aquatic and riparian habitat, is also expected to enhance the aesthetics of the area to visiting sports persons and tourists, in general, regardless of their objectives in visiting the Jackson Hole area. By increasing the amount of vegetation in some areas, people may have a better experience when they go fishing. Most fishermen probably would rather see trees and other vegetation than bare cobble and gravel.

Local jobs maintained by the $143,000,000 output related to sportsfishing, accounts for about 25 percent of the total employment of Teton County. This is based on statistics furnished by the Jackson Hole Economic Development Council web site. Local nonfarm sales in 1997 were estimated at $583,000,000 based on sales tax receipts of $35,000,000 in this sector. The sales tax rate of 6 percent would indicate gross sales of $583.000,000. Approximately 18,500 workers generated this $583,000,000 in sales. This allows each worker to generate $31,600 sales per year. If the $143,000,000 sportsfishing output and sales is maintained, 4,500 jobs would be enhanced in the area. No consideration was given to the cost of each option since those numbers are not available at this time.

6.8 RECREATION

The Snake River in the vicinity of the four project areas principally experiences recreational use from rafting and fishing. Some waterfowl hunting also occurs on the river. Levees along the four project areas are used for a variety of recreational purposes including walking, hiking, jogging, bicycling, cross country skiing, horseback riding, bird watching, nature viewing, picnicking, and other similar uses. The levees also provide access for direct river use such as fishing and waterfowl hunting.

The majority of recreational use for the four project areas occurs near the Highway 22 Bridge (Area 9), also known as the Wilson Bridge. Recreational use at this site occurs year-round, with high use continuing into November. South Park Elk Feed Grounds receives limited public recreational use, most of which occurs during summer as hiking and nature viewing (personal communication, Tim Young, Jackson Hole Community Pathways, November 1998). The southwest levee at

Wilson Bridge experiences considerable use. The northwest levee gets only limited use while the southeast levee does not get any use. The northeast levee gets a lot of use due to the close proximity of a park (personal communication, Franz Carmindzend, Jackson Hole Alliance, October 1998).

A 1990 report filed by the WGFD, Jackson Field Office, indicated that during the summer months, the Wilson Bridge site experienced 2,313 user days by fishermen using the upper stretch and 1,804 user days on the lower end. A precise count for 1998 is not currently available. It is likely the area experiences the same or slightly higher levels of use than 1990.

Camping on islands and on shore sites is prohibited by the settlement of a lawsuit between the BLM and landowners. With the landowners in control of how the land is used in the proposed project reach, many recreational restrictions exist. Camping is one of the recreational uses that is prohibited in all but one or two sites. These sites are very rarely used.

The proposed action has the potential for both short-term and long-term impacts upon recreational uses. Recreational use could potentially be affected by construction, impacts from the presence of completed structures, and impacts from structure maintenance.

The effects of construction activity would occur principally in the form of short-term impacts. These impacts would occur during ingress and egress of equipment to the work sites and during actual on-site construction. Access to the work sites would occur over a variety of routes and for a variety of purposes. Access would be necessary to transport equipment, materials, and supplies to and from the work sites. Some routes would require use of levees and others would not. Of the levees that would be used for ingress and egress, some receive recreational use and others do not. Those that receive recreational use have the potential for user conflicts to develop.

Use of the Sewell and Lower Imenson Levees would be necessary to access Area 1. The public does not have access to either of these levees. The Federal Levee Extension would be used to access the east side of Area 4. There is no public access to the Federal Levee Extension at the east side of Area 4. The Right Bank Federal Levee would be used to access the west side and the Left Bank Federal Levee used to access the east side of Area 9. Access to reach the Left Bank Federal Levee on the east side at Area 9 would be through an existing conservation park used by recreationists. Access to the Right Bank Federal Levee at Area 9 would occur upon an existing unpaved road leading to a boat launch and parking area. The public has access to both the Right and Left Bank Federal Levees at Area 9. Area 10 would be accessed via the Right Bank Federal Levee on the west and the Left Bank Federal and Hanson Levees on the east. There is no public access to levees at Area 10.

Operation of equipment upon levees accessible to the public would create a conflict for persons hiking or walking the levee. As indicated above, traffic control measures, such as flaggers or signage, would be used at locations that would experience more than minimal conflicts between recreationists and construction-related activity. Such situations would be identified and resolution measures implemented by the local sponsor. Impacts from construction-related activity upon levee users would be temporary and would be minimized through the use of measures referenced above.

Gravel removal to maintain channel capacity and construct channel stabilization pools would occur in areas of the primary river channel. In-channel work may also involve construction of temporary water diversions or berms to reroute flows and de-water gravel removal sites. Spur dikes would be constructed adjacent to levees where the high-velocity flows of the primary channel occur. Rafters and float fishermen would be the primary recreationists likely to be affected by the in-channel work. Fishermen fishing from the bank or wading would be less affected. The primary effect upon rafters and float fishermen would occur from the temporary alternation of the primary channel flow. The proposed gravel removal would have only a minor effect upon rafters and float fishermen.

Presence of completed eco fences, channel stabilization pools, anchored root wad logs, and spur dikes would change the configuration of the river channel and effect flow patterns. Eco fences, anchored root wad logs, and spur dikes would result in more permanent changes to the channel than would the channel stabilization pools. Channel stabilization pools would trap bedload materials, therefore, would become less prominent over time. However, maintenance of the channel stabilization pools after they have filled with bedload material would result in renewed changes in configuration and flows.

Permanent changes in the channel are expected to have long-term, yet minimal impacts upon rafters and float fishermen. Rafters would have to become accustomed to the new configuration and flows resulting from spur dikes, anchored root wad logs and eco fences. Because these structures would not be in the middle of the primary flow, rafters and float fishermen should have little difficulty negotiating or bypassing the structures. The effort required for rafters and float fishermen to learn the new changes are expected to be no greater than is required each year after seasonal high flows. The permanent changes in configuration and flow would not de-water the channel or restrict access. The permanent changes have considerable potential to provide long-term benefits to recreational users through the creation of additional fish habitat.

If structures are damaged by high flows, parts of structures, such as cables from eco fences, could pose a hazard to rafters and float fishermen. To alert river users to the presence of the new structures, the local sponsor would implement a public information campaign and perform monitoring and maintenance to identify potentially unsafe structure conditions.

Gravel removal to maintain channel capacity and construct channel stabilization pools is expected to have even less impact on recreationists than the eco fences, channel stabilization pools, anchored root wad logs, and spur dikes. Channel stabilization pools would cause slower flows, creating a pool effect, therefore, would not pose as a hazard or barrier to floaters. This change is not expected to have more than a minimal effect on rafters and float fishermen. Floaters and rafters would likely experience improved floating conditions due to stabilization of the channel. Overall, the permanent, long-term effects upon recreation resulting from the presence of the completed structures are expected to be minor.

The effects of maintenance upon recreation activities would be similar to those resulting from construction. However, work required to perform maintenance is reasonably expected to be less than would be required to actually construct the environmental restoration project. Primary effects would result from ingress and egress of equipment and actual construction activity and would be short-term.

Levees at Area 9 actively being used in support of construction would be clearly signed at all access points to alert users to the presence of trucks and other equipment. Because the greatest use by recreationists occurs on the Left and Right Bank Federal Levees upstream of the Wilson Bridge at Area 9, the greatest inconvenience upon recreationists would likely occur at these locations.

A flagger would be posted, when necessary, at the Area 9 boat ramp to coordinate use between recreationists and construction equipment using the site for ingress and egress to construction areas.

A public information campaign would be implemented by the local sponsor to inform the recreating public about the environmental restoration project and possible conflicts between recreationists and construction activities. The campaign would include installation of appropriate signage at all levee access points and at the ramp and conservation park at Area 9. An information brochure would be prepared and distributed by the local sponsor to all fishing and rafting outfitters as well as placed at information boards at public access areas. Other sources available to the local sponsor for distributing information to the public may include the print media and radio. The campaign would be implemented both prior to and during construction.

6.9 AESTHETICS

The proposed environmental restoration project would occur within the Snake River between the levees near the Jackson Hole, Wyoming, area. The Jackson Hole area is popular as a year-around recreation destination. The area's spectacular scenery is of national significance, as evidenced by the establishment of the Grand Teton National Park in 1929.

The proposed environmental restoration project areas are located in the outwash plain of the Snake River. The river channel is relatively wide and braided with

extensive areas of gravel bars. Riparian vegetation is found along many of the channels. Stands of trees, composed primarily of cottonwoods, willow, and alder are scattered throughout the outwash plain.

Views of the floodplain, by boaters and other recreationists using the Snake River, are generally restricted because of adjacent riverbanks, levees, and vegetation. The primary views along the rivers are of the mountains, particularly the Grand Teton Mountains, which can be viewed beyond the riverbanks and levees in locations where there are openings in the riparian vegetation.

Within the past few years, Area 1 has undergone extensive lateral erosion due to the "fire hose" effect of concentrated river flows emerging from the confined channel upstream. The installation of eco fences and anchored root wads would help to reestablish island vegetation as well as help protect existing islands and encourage growth of new islands.

The vegetation at Area 4 is predominately shrub-willow. Most of the existing islands currently within the channel are devoid of vegetation due to island instability and changing river flows. The installation of eco fences and anchored root wad logs would help reestablish island vegetation.

The river at Area 9 is somewhat restricted and the islands are devoid of vegetation. The vegetation along the shoreline is predominantly shrub-willow. Rock grade control structures would be constructed flush with the existing channel bottom and would help prevent bank erosion and degradation of existing habitat. Eco fences and anchored root wad logs would assist in revegetation of existing islands and establishment of new islands. Spur dikes would be used to provide bank protection and enhance fisheries habitat by creating flow diversity and enhancing pools, fish resting areas and riffles, thus improving the visual quality of the riverbanks.

Area 10 is located at the confluence of the Gros Ventre and Snake Rivers. This area has extensive cottonwood vegetation on existing islands and along the shoreline. Eco fences and anchored root wad logs would assist in promoting a more diverse vegetative cover along existing shorelines and encourage the growth of new islands. Spur dikes would enhance fish habitat and provide additional bank protection. This would allow regeneration of native plants as well as improve the visual quality of the riverbanks.

The removal of gravel to maintain channel capacity and construct channel stabilization pools and the presence of the anchored root wad logs, eco fences, off-channel pools, and secondary channels are not expected to contrast sharply with the existing surroundings. The proposed measures are expected to create long-term potential for restoring aquatic and terrestrial habitat along the environmental restoration project area. Over time, with the reestablishment of islands and vegetation, the aesthetics of the project area would improve.

6.10 CULTURAL RESOURCES

The area of the proposed environmental restoration project includes floodplain areas between the levees along the Snake River. This area is part of the glacial outwash plain that forms the floor of the area referred to as Jackson Hole. The surface has been modified by fluvial deposition and erosion caused by the Snake River and its tributaries. Soils are generally deep, loamy soil types with a high proportion of rock fragments. Stream crossing locations typically exhibit river cobbles or gravel with some sandy soil cover. The valley floor is interrupted in places by ridges and buttes, formed by remnant volcanic and intrusive rocks.

A Class 2 reconnaissance survey was performed within the generalized environmental restoration project areas during the period August 12 to 16, 1996, by the Walla Walla District's staff archaeologist. Record searches were also conducted. No previously unrecorded cultural properties were found during the reconnaissance survey. Record searches identified two previously recorded sites close to two of the proposed environmental restoration project areas but outside of the levees.

Because the previously recorded sites are located outside of the levees, away from where the proposed actions would occur, the Corps determined the environmental restoration project would have no effect on any previously listed cultural property. The Corps also determined the potential for the occurrence of any unrecorded cultural properties in the areas of impact to be low.

A copy of the Corps' Survey Report was forwarded to the Wyoming Division of Cultural Resources, State Historic Preservation Office (SHPO), for review and concurrence. In their letter of February 12, 1997, the SHPO responded that no sites meeting the criteria of eligibility for the National Register of Historic Places would be affected by the environmental restoration project. The SHPO recommended the project proceed in accordance with state and Federal laws, subject to the following stipulation: "If any cultural materials are discovered during construction, work in the area should halt immediately and the Corps and SHPO staff must be contacted. Work in the area may not resume until the materials have been evaluated and adequate measures for their protection have been taken." Refer to appendix D for the SHPO letter concurring with the Corps' determination of "no effect."

6.11 CUMULATIVE EFFECTS

The Flood Control Act of 1950 authorized flood protection by levees and revetment along the Snake River in the Jackson Hole, Wyoming, area. The project was completed in the fall of 1964. Levees have been added to the system by other agencies and by "emergency flood fight" operations of the Corps and Teton County through 1997. The effect of these measures has been the alteration of the physical character of the river, both inside and outside of the levees, along approximately 25 miles between Moose Bridge and South Park Elk Feed Grounds. Presently, the

width of the Snake River floodplain is reduced by the levees, flow velocities through the leveed sections are increased, elevated quantities of bedload material is transported through the area, and island and associated vegetation is eroding. Water flows to spring creeks outside of the levees have been reduced. Spawning habitat for cutthroat trout has been reduced or destroyed and the composition and quality of riparian vegetation outside of the levees is changing.

During the winter of 1998-99, Teton County coordinated a demonstration project within this same stretch of river near the Wilson Bridge. Approximately 6,000 cubic yards of cobble and gravel were excavated to construct three off-channel pools. Approximately 1,600 linear feet of channel was excavated to maintain flow capacity within 100-year event flows. Five-pile eco fences totaling approximately 500 linear feet were also constructed. The purpose of the demonstration project was to implement measures to counteract the adverse resource effects of the existing levees and revetment. Effects of the demonstration project would be the long-term improvement of water quality, stabilization of the channel, and establishment of aquatic and terrestrial habitat.

During the same period, Teton County also constructed a kicker along the left bank of the river just above the Wilson Bridge to diminish effects of flows on the levee. This work was conducted in accordance with a Local Cooperation Agreement signed by the Corps and Teton County in September 1990 for the performance of levee maintenance. Teton County conducts annual operations to maintain the levees; however, the maintenance operations do not increase or expand effects to the existing levees and revetment on the Snake River.

The environmental restoration measures being proposed under the Jackson Hole, Environmental Restoration Project, would have both short- and long-term effects on the Snake River. Environmental restoration measures proposed for Area 1 include excavation of a single channel stabilization pool and four off-channel pools with connecting upstream and downstream secondary channels, construction of eco fences, and placement of anchored root wad logs. Construction would result in minor, nonbeneficial short-term impacts to water quality, air quality, aesthetics, recreation, aquatic and terrestrial species and habitat, and local transportation. Presence of the completed structures would have long-term beneficial effects upon water quality, recreation, and aquatic and terrestrial species and habitat. The changes attributable to the collective effect of actions proposed for Area 1 would decrease nonbeneficial effects of past flood control activities and cause an overall net increase in beneficial effects in the long-term. There would be no measurable increase in the baseline detrimental effects caused by previous flood control activities.

Environmental restoration measures in Area 4 would include: excavation of two channel stabilization pools and three off-channel pools with connecting upstream and downstream secondary channels; construction of eco fences and spur dikes; placement of anchored root wad logs; and removal of gravel to maintain channel

flow capacity within 100-year event flows. Construction would result in minor, nonbeneficial short-term impacts to water quality, air quality, aesthetics, recreation, aquatic and terrestrial species and habitat, and local transportation. The completed structures would cause long-term beneficial effects upon water quality, recreation, and aquatic and terrestrial species and habitat by stabilizing the channel and allowing recovery of aquatic and terrestrial habitat. Actions proposed in Area 4 would not add to the cumulative adverse effects caused by previous flood control actions at Area 4.

Environmental restoration measures in Area 9 would include: construction of eco fences, placement of anchored root wad logs, and removal of gravel to maintain channel flow capacity within 100-year event flows. Construction would result in minor, nonbeneficial short-term impacts to water quality, air quality, aesthetics, recreation, aquatic and terrestrial species and habitat, and local transportation. Presence of the completed structures in Area 9 would result in long-term beneficial effects upon water quality, recreation, and aquatic and terrestrial species and habitat. The changes attributable to the collective effect of actions proposed for Area 9 would decrease nonbeneficial effects of past flood control activities and cause an overall net increase in beneficial effects in the long-term. No measurable increases in the net detrimental effects caused by previous flood control activities would occur.

Environmental restoration measures in Area 10 would involve excavation of a single channel stabilization pool and two off-channel pools with connecting upstream and downstream secondary channels, construction of eco fences, placement of anchored root wad logs, and removal of gravel to maintain channel flow capacity within 100-year event flows. Construction in Area 10 would also cause minor, nonbeneficial short-term impacts to water quality, air quality, aesthetics, recreation, aquatic and terrestrial species and habitat, and local transportation. Water quality, recreation and aquatic and terrestrial habitat would benefit in the long-term from the presence of the completed structures. Changes caused by the cumulative effect of actions proposed for Area 10 would cause the nonbeneficial effects from past flood control activities to diminish. In the long-term, an overall net beneficial increase in aquatic and terrestrial habitat would occur.

The cumulative effect of past and proposed actions along the Snake River would not cause additional reduction in the width of the floodplain, increase flow velocities through the levied areas, increase transport of bedload material, destabilize the channel, erode islands and vegetation between the levees, or diminished flows to spring creeks outside of the levees. The cumulative effect of the proposed environmental restoration project would be improved water quality through reduced velocities and stabilization of the channel, reduced erosion of islands and loss of vegetation, opportunity for the reestablishment of islands and vegetation, and creation of additional habitat for cutthroat trout and other aquatic and terrestrial species.

7.0 COMPLIANCE WITH ENVIRONMENTAL PROTECTION STATUTES AND REGULATIONS

The following paragraphs address the principal environmental review and consultation requirements applicable to this environmental restoration project. Pertinent Federal statutes, executive orders, and state permits are included.

7.1 FEDERAL STATUTES

7.1.1 National Historic Preservation Act, As Amended; Executive Order 11593, Protection and Enhancement of the Cultural Environment, May 13, 1971

The proposed action was evaluated for compliance with the above Act and Executive Order; and a report was coordinated with the Wyoming Department of Cultural Resources, SHPO. The SHPO concurred that no sites meeting the criteria of eligibility for the National Register of Historic Places would be affected by the proposed action. This environmental restoration project would, therefore, be in compliance with the Act and the Executive Order.

7.1.2 Clean Air Act, As Amended

Construction activities would result in only minor, short-term exhaust emission from construction equipment. Fugitive dust from this environmental restoration project would also be minimal. This project would be in compliance with the Clean Air Act.

7.1.3 Clean Water Act

Section 404 of the Clean Water Act [33 United States Code 1344] requires evaluation of activities involving discharges of dredged or fill material into waters of the United States, including wetlands. The 404(b)(1) Guidelines [40 Code of Federal Regulations (CFR) Part 230] are the substantive criteria used in evaluating discharges of dredged or fill material under the Act. The Corps has prepared an evaluation (appendix E) of discharges associated with the environmental restoration project, in accordance with the Guidelines. The evaluation will be used to solicit water quality certification from the State of Wyoming, DEQ. The Corps would not initiate discharges in the Snake River until the environmental restoration project has been certified or conditionally certified.

7.1.4 Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act of 1958 (Public Law 85-624) requires that when the water of a stream or other body of water are proposed to be impounded, diverted, channel deepened, or stream or other body of water otherwise controlled or modified for any purpose, the USFWS be consulted. The USFWS was tasked with writing a CAR. The CAR was completed, reviewed by the Corps, and finalized on

October 27, 1998. See appendix B. This environmental restoration project is in compliance with the Act.

7.1.5 Endangered Species Act of 1973, As Amended

A list of threatened or endangered species that might occur in the vicinity of the environmental restoration project was obtained from the USFWS. The Corps prepared a BA of potential effects of the project upon the listed species. In their letter of November 30, 1998, the USFWS responded that the project may affect, but would not likely adversely affect, the bald eagle, peregrine falcon, whooping crane, grizzly bear, and gray wolf. See appendix A.

Based on the above, this environmental restoration project would be in compliance with the Act. However, construction is not scheduled to begin until 2001 and only one area would be constructed each year between 2001 and 2004. If construction is not begun within 180 days of the date the above species list was issued, a new species list must be obtained and a review of the BA completed. If construction is implemented in accordance with the above schedule, a new species list and review of the BA would be required prior to each year of the proposed 4-year construction phase.

7.1.6 The NEPA

This EA has been prepared pursuant to requirements of the Act. No significant impacts have been identified at this time. If no significant impact is identified during the public review process, an EIS would not be required. If an EIS is not required, full compliance with NEPA would be achieved upon the signing of a Finding of No Significant Impact (FONSI).

7.1.7 Wild and Scenic Rivers Act

This segment of the Snake River is not included on the inventory of wild and scenic rivers. (National Wild and Scenic Rivers System, December 1992 and its 1997 updates, published by Department of the Interior and the Department of Agriculture, Forest Service.)

7.1.8 Migratory Bird Treaty Act

The environmental restoration work would be performed in such a manner that migratory birds or their habitat would not be harmed or harassed. The proposed work would be performed outside of the major nesting season for most birds. Bird species that nest later in the summer, such as the American goldfinch (*Carduelis tristis),* may be impacted by noise and activity associated with construction and gravel sorting. The proposed action does not involve the removal of mature trees that may be used for nesting by bird species protected by this act. Some brush and small trees would be damaged or removed during construction of side channels and

pools. If there are no bald eagles nests found within 1 mile of the environmental restoration project area, work may begin earlier than August 15 after consultation with the USFWS. This consultation is necessary to ensure no other nesting migratory birds would be impacted by the construction activity.

7.2 EXECUTIVE ORDERS

7.2.1 Executive Order 11988, Floodplain Management, May 24, 1977

The use of structures such as eco fences, spur dikes, and anchored root wad logs for restoration purposes necessitates their construction within the 100-year flood profile. However, such environmental restoration measures would not directly or indirectly support development in the base floodplain. Most of the channel modifications would fall within the regulatory floodway as delineated by the Federal Emergency Management Agency in their May 4, 1989, Teton County Flood Insurance Study (FIS). The area is designated as a no-rise area, meaning that actions within or adjacent to the floodway should not result in a rise in the regulatory, 100-year flood water-surface profile.

To assist in assessing the potential for a reduction in the base floodplain, hydraulic modeling of the Snake River in each of the study areas was performed using HEC-2, a computer-based backwater model developed by the U.S. Army HEC. In Area 1, comparison of the profiles with and without the environmental restoration measures indicates that the environmental restoration project would result in lowering the water surface profile up to about 1 foot in the excavated areas. The environmental restoration measures in this area are not expected to result in a rise in the 100-year flood profile.

At Area 4, the proposed environmental restoration measures would lower the existing profile (1996) at or below the regulatory level for all areas within the environmental restoration area. Based on observed water surface profiles at Area 9, along with results of the hydraulic modeling, it does not appear the environmental restoration measures would result in any rise above the regulatory 100-year profile. For Area 10, the restored channel profiles would be below the 100-year profile.

The proposed action would not decrease the base floodplain or support development in the floodplain. Based on these findings, the environmental restoration project would be in compliance with the Order.

7.2.2. Executive Order 11990, Protection of Wetlands, May 24, 1977

The proposed action is intended to restore and protect riparian and wetland habitat. The proposed environmental restoration tools would be strategically placed to prevent erosion of riparian and wetland areas and to facilitate conditions suitable for wetland development. The proposed action would not support new construction in wetlands.

The contractor would coordinate with the Corps' biologist, representative for the (Jackson Hole) flood control project, and the landowner (in the field) to determine the optimum access routes and locations for structure placement to avoid (to the extent possible) impacts to existing wetlands. The proposed action would be in compliance with the Order.

7.3 STATE PERMITS

No permits are required from the State of Wyoming at this time. If, however, the State of Wyoming determines during their review of this EA that a permit is required, the local sponsor would take appropriate action to apply for and obtain the necessary permits prior to the start of construction.

7.4 ADDITIONAL REQUIREMENTS

A Temporary Gravel Extraction and Processing Permit must be obtained pursuant to Teton County Land Development Regulation. The local sponsor would apply for the permit through the Teton County Planning Department prior to the start of construction.

A permit must be obtained from the BLM prior to initiation of gravel removal from lands administered by that agency. The local sponsor would obtain the permit.

7.4.1 Noise Standards, 24 CFR 51 B

Noise would occur principally in association with truck transportation of materials and supplies, operation of excavation equipment, operation of equipment to screen cobbles, and operation of jackhammers for installation of root wad lag anchors.

Noise generated on site by the environmental restoration project would be experienced primarily by recreational users in the vicinity of construction areas. Most of the lands along the river segment are undeveloped. Public access to the project areas is primarily limited to levees extending upstream and downstream of Wilson Bridge near Area 9; therefore, most impacts of on-site noise will be concentrated around Area 9. Access to other areas of the project would occur by private landowners or by rafters or floaters. Rafters and floaters would be exposed to the increased noise levels when passing through the construction area. Truck traffic noise would be experienced by travelers on roadways being used for ingress and egress to active construction sites. Gravel removal and processing activities in the vicinity of Area 9 contribute to the existing background noise.

Increased noise levels would be restricted to daylight hours. Any increases in noise levels beyond existing background levels would be short-term.

7.4.2 The CEQ Memorandum, August 11, 1990, Analysis of Impacts of Prime or Unique Agricultural Lands in Implementing NEPA

No prime or unique farmland would be adversely impacted by construction. Access routes are not expected to cross farmlands. The environmental restoration project areas are all within the floodway. Many are bound by existing levees.

8.0 COORDINATION

This environmental restoration project has been coordinated with applicable agencies including USFWS, USFS, U.S. Environmental Protection Agency. BLM. Natural Resources Conservation Service, WGFD, Wyoming DEQ, Wyoming Division of Cultural Resources SHPO, and Wyoming Department of Transportation. Additionally, this EA has been distributed to interested members of the public for their review and comment.

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APPENDIX A

BIOLOGICAL ASSESSMENT
AND
ENDANGERED SPECIES ACT SPECIES LIST

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Ecological Services
4000 Morrie Avenue
Cheyenne, Wyoming 82001

ES-61411
pd/W.06/wy2055.pd

November 30, 1998

Mr. Peter F. Poolman
Chief, Environmental Compliance Branch
U.S. Army Corps of Engineers
Walla Walla District
201 North Third Avenue
Walla Walla, Washington 99362-1876

Dear Mr. Poolman:

Thank you for the Biological Assessment for the Jackson Hole Environmental Restoration Project, Snake River, Teton County, Wyoming received by our office on October 26, 1998.

Based on the information provided in the Biological Assessment, and a fax tramission from Mr. Scott Ackerman of your staff dated November 30, 1998, we concur with your assessment that the project, as described, may affect, but is not likely to adversely affect the threatened bald eagle (*Hailieetus leucocephalus*), peregrine falcon (*Falco peregrinus*), whooping crane (*Grus americana*), grizzly bear (*Ursus arctos*) and gray wolf (*Canis lupus*). However, if the scope of the project is changed, or the project is modified, in a manner that you determine may affect a listed species, this office should be contacted to discuss consultation requirements pursuant to section 7(a)(2) of the Endangered Species Act of 1973, as amended.

We appreciate your efforts to ensure the conservation of endangered, threatened and candidate species. If you have further questions on this subject, please contact Pat Deibert of my staff at the letterhead address or phone (307) 772-2374, extension 26.

Sincerely,

Michael M. Long

Michael M. Long
Field Supervisor
Wyoming Field Office

Mr. Peter Poolman
U.S. Army Corps of Engineers

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cc: Director, WGFD, Cheyenne, WY
Nongame Coordinator, WGFD, Lander, WY

DEPARTMENT OF THE ARMY
WALLA WALLA DISTRICT, CORPS OF ENGINEERS
201 NORTH THIRD AVENUE
WALLA WALLA, WASHINGTON 99362-1876

Reply To
Attention Of:

October 19, 1998

Planning Division

Mr. Michael Long, Field Supervisor
Wyoming Field Office
U.S. Fish and Wildlife Service
Ecological Services
4000 Morrie Avenue
Cheyenne, Wyoming 82001

Dear Mr. Long:

Pursuant to Section 7(c) of the Endangered Species Act, we request your review and informal consultation on the proposed project as described below and concurrence on our *"May Affect But Is Not Likely To Adversely Affect"* determination.

Project Title

Jackson Hole Environmental Restoration Project, Snake River, Teton County, Wyoming

Project Purpose, Location, and Actions

Purpose

The following synopsis was derived from Appendix B Engineering (Draft) from the "Jackson Hole, Wyoming, Environmental Restoration Feasibility Study" which has already been received by your office. This synopsis does reflect some minor changes which were added after Pat Deibert received and commented on the initial draft of this document.

The purpose of the Jackson Hole, Wyoming, Environmental Restoration Project is to improve riparian and riverine habitats which have degraded over the years. The Snake River, in this area, is confined by levees that concentrate the river flows causing excessive erosion of existing vegetation and wildlife habitat.

In an effort to protect the remaining vegetation and encourage growth of new vegetation, several tools for protection and environmental restoration were developed in this study.

Location

The proposed work area is located on the Snake River near the towns of Wilson and Jackson in Teton County, Wyoming. Area 1 is located in sections 13, 14, 23 and 24, Township 40N, Range 117W. Area 4 is located in sections 2, 3, 10 and 11, Township 40N, Range 117W. Area 9 is located in sections 13, and 24, Township 41N, Range 117W. Area 10 is located in sections 5, 6, and 7, Township 41N, Range 117W.

Tools for Restoration

The project involves five restoration tools that were adopted from other river restoration projects. Due to the extreme nature of river conditions, each restoration tool was designed to withstand high-river forces. The restoration tools consist of gravel removal, brush fences, anchored root wad logs, rock grade control, and spur dikes.

a. Gravel Removal

The functions for gravel removal consist of improving fish habitat, maintaining channel capacity, increasing channel stability, and improving sediment transport. Three different gravel removal tools would be used to perform these functions. They include channel capacity excavations, side pools, and sediment traps.

(1) Channel Capacity Excavations

One of the primary objectives of the project is to increase the vegetation between the levees. If this objective is achieved, then the flow capacity of the river will diminish. In order to maintain the current flow capacity, it would be necessary to remove some of the existing riverbed material. The removal of riverbed material would be accomplished with channel capacity excavations, which would be needed in areas 4, 9, and 10. No channel capacity excavations are planned for area 1. Area 1 currently has a very large flow capacity and has room to allow for the projected growth of vegetation without creating a potential flood hazard.

Channel capacity excavations would be designed to maintain the 100-year flood while considering the projected amount of vegetative growth between the levees. The amount of vegetation corresponds to the projected amount of channel blockage.

Excavations would vary in depth from 0 to 8 feet with an average depth below ground of 4 feet. Excavations would extend down to the adjacent thalweg.

In order to maintain channel bottom stability, the channel bottom would be armored with 4-inch-plus material obtained from the excavation. The armor material would be placed in rows spaced 10 feet apart on center aligning perpendicular to the channel centerline. The rows would have a cross-sectional area equivalent to 10-square feet. This would provide a volume of armor equivalent to a 1-foot-thick layer of armor on the channel bottom.

(2) Side Pools

Side pools would be excavated in the existing gravel bars to provide pools for fish habitat. The gravel bars are very expansive, generally up to 600 to 800 feet in width and devoid of vegetation. To minimize excavation, side pools would be sited in existing low-lying areas.

Pools would be excavated to provide approximately 4 feet of water depth during low flow. In order to create a natural appearance and to maximize wildlife benefits, the slopes of the pools would be varied. The upstream end of the pools would be protected with a 12-inch-thick layer of cobbles.

Supply channels would be needed to provide water to and from the side pools. Existing secondary channels would be cleared through excavation, as much as possible, to allow water to run to and egress from the pools. In areas where no secondary channel exists, new channels would be excavated. To add fish value, the depth of excavation would be varied from 1 to 4 feet below the low flow water line. The estimated average depth of these excavations is 1 foot with a bottom excavation width of 4 feet.

(3) Sediment Traps

Sediment traps would be excavated to catch bed load material, thereby, lessening downstream sediment deposition and maintaining the channel capacity. A secondary benefit would be improved fish habitat from the creation of a large pool.

Sediment traps would vary from 20 to 35 acres in surface area and would be excavated to the adjacent thalweg elevation. The depth of excavation generally varies from 2 to 6 feet with an average of 4 feet. The side slopes would be varied. The bottom of the sediment traps would be armored with 4-inch-plus cobble.

b. Brush Fences

Brush fences have two main purposes: reestablish island riparian habitat and protect existing island riparian habitat. Brush fences and woody debris placement would be used to slow water velocities and reduce energy impacting the islands. The intent of slowing the water velocities is to decrease island erosion and induce sedimentation to augment the island-building processes.

The brush fence tool was developed to collect floating woody debris to form a shield that would protect existing riparian zones and induce sedimentation downstream of the brush fence. The brush fences would be situated to protect islands with existing riparian habitat. They would also be situated along barren islands to increase sedimentation and vegetation growth.

There are two types of brush fence designs. One brush fence design consists of piling with lateral cables strung between the piling. The other brush fence design is constructed of riprap.

(1) Piling Brush Fences

Pipe (6 inch) and "H" pile (8x36 and 10x42 inches) would be used with wire rope to construct the piling brush fences.

(2) Rock Brush Fences

The purpose for considering a rock brush fence is to investigate an alternative to a piling fence that would be suitable for withstanding the high river forces. The rock brush fences would consist of riprap with side slopes of 2 horizontal to 1 vertical and an embedment depth of at least 4 feet below the adjacent ground line. Riprap would be placed to a top elevation of 1 foot below the 100-year flood.

c. Anchored Root Wad Logs

Root wad logs would be anchored to the river bottom. These two methods would be employed in their placement: staggered placement and scattered placement. Staggered placement would be used to protect existing islands and to encourage the growth of new islands. Whereas, scattered placement would be used to increase the amount of woody debris in the river system.

d. Rock Grade Control

A rock grade control structure would be used in area 9 to keep the river from eroding through existing riparian habitat. The rock grade control structure would consist of riprap. The top surface of the rock grade control structure would be flush with the existing channel bottom. Rock grade control structures may be constructed in other areas to prevent channel down-cutting.

e. Spur Dikes

Spur dikes would be situated along the levees for fisheries habitat enhancement and bank protection creating flow diversity that provides relatively slack water where steady current was found before.

There are two kinds of spur dikes under consideration, kickers and bank barbs. Kickers, which are the larger of the two, would be composed of riprap armor with a random fill core and extend approximately 56 feet into the river. Bank barbs would consist of only riprap and extend approximately 26 feet into the river. The larger size of the kicker would provide a scour hole at the end of the kicker and more slack water for fish habitat.

Construction

Due to the varying nature of site conditions, a Corps hydrologist and a Corps biologist would be on site to ensure that the project was constructed as planned. It is anticipated that the work would be contracted out through an equipment rental contract. Environmental stipulations will be addressed in this contract. Corps personnel will provide oversight of the ongoing work.

a. Gravel Removal

Work would be accomplished with excavators, loaders, dump trucks, and grizzlies. Depending on Wyoming State Department of Environmental Quality recommendations, construction equipment would not be operated in flowing water. In order to keep the equipment out of flowing water, it may be necessary to divert the water away from the excavations. This would be accomplished with diversion dikes and/or diversion channels. Diversion dikes would be constructed with existing riverbed material adjacent to the dike.

b. Piling Brush Fences

Piling brush fences would be constructed by first excavating out the high points along the fence alignments so that the bottom wire can be installed. Next, the piling would be driven to the required penetration depths with a backhoe mounted with a vibratory hammer. Holes would then be drilled through the piling to thread the wire rope through. At every fifth piling, a wire rope connection would be welded to the piling. After installation of the wire rope, trenches would be backfilled and compacted.

c. Rock Brush Fences

A trench along the alignment would be excavated to a depth of 4 feet below the adjacent ground line with an excavator. The trench would be wide enough to allow for the footprint of the structure. Material from the excavation would be hauled off site.

d. Anchored Root Wad Logs

Root wad logs, existing on site, would be used as much as possible to minimize the expense of hauling logs to the site. Logs would be transported to the site by truck, rubber-tired skidder, or helicopter. Specific source locations would be designated in the field by a Corps representative. Log removal will not be performed in areas where the action would promote excessive erosion or damage existing riparian vegetation.

A backhoe may be used to level out an area to place the logs so that the log would have uniform bearing along its trunk and its root would be partially embedded. The log would be fastened down with toggle bolt anchors. The anchors would be driven into the ground with a jackhammer and a jack would be used to pull up on the anchors locking them into place. The cable would be tied around the log and synched down to tighten the log to the ground.

e. Rock Grade Control

The footprint of the rock grade control structure would be excavated. Material resulting from the excavation would be hauled off site. Riprap would be placed in the excavation area by carefully keying the riprap together to minimize voids to form a locked mass.

f. Spur Dikes

The spur dikes, which include both kickers and barbs will be constructed with an excavator on the levee. Dump trucks would haul materials to the spur dike location along the top of the levees.

Construction Materials:

a.. Riprap

The contractor would be responsible for selecting riprap sources that would provide the necessary quantity and quality of materials meeting the requirements. Riprap can only be obtained from a permitted quarry site. The contractor would be responsible for making arrangements with the quarry operators concerning availability of riprap. One potential source would be the quarry reject pile at Walton Quarry owned by the State of Wyoming. For more information regarding this site, contact Teton County. The contractor would comply with all applicable local, State, and Federal laws and regulations including, but not limited to, the Clean Water Act; Resource Conservation and Recovery Act; and Comprehensive Environmental Response, Compensation, and Liability Act.

b. Woody Debris

Woody debris would be obtained from on-site and off-site sources selected by the contractor. It is estimated that 3,000 root wad logs, acceptable for construction, are scattered along the river. An additional 200 root wad logs are piled at Walton Quarry. The woody debris available on site would be used first. Additional woody debris would be obtained off site. Other possible sources for off-site woody debris include Jackson Lake. Palisades reservoir can not be used as a site due to the presence of whirling disease. Because of the possibility of whiling disease in other areas, approval for root wad log acquisition sites will be made by U.S. Fish and Wildlife Service or Wyoming Game and Fish Department.

Root wad logs of deciduous and coniferous tree species would be acceptable. They would be at least 8 feet in length and no longer than 20 feet. The stem would be at least 12 inches in diameter and the roots would remain intact.

Construction Access

Access to the work areas will generally originate from the public highway system and traverse over existing easements to the levees. The roads for the levee access easements are typically dirt roads and are suitable for moving construction equipment. For cost estimating purposes, it is assumed that gravel resulting from the excavations would be hauled 12 miles from each area.

Flows in the Snake River are too high to allow for construction access from only one side of the river so access from both sides of the river would be necessary. For convenience, the following describes the access points by the west access and the east access.

The sensitivity of some riparian areas will require some coordination to determine the best access route. A Corps biologist should be consulted as to the best access route through riparian vegetation so impacts to these areas can be minimized.

a. Area 1

(1) West Access

The west portion of area 1 would be accessed from Fall Creek Road and involves two different access points. The first access point is for the downstream work area. The access originates off of Fall Creek Road and follows a dirt road to Sewell Levee. It would then continue along Sewell Levee to the work area. The access to the upstream work area would also originate from Fall Creek Road and would follow a dirt road to the work area. This access will need to be determined in the field.

(2) East Access

The east portion of area 1 would be accessed from the north from South Park Loop along a 1-mile stretch of gravel road to the Lower Imenson Levee. Once on the levee, construction equipment would follow the levee until it terminates. After the levee ends, access would continue through existing shrubs and trees and over gravel bars. The contractor would coordinate with the Corps in the field to determine the optimum routes for minimizing disturbances.

b. Area 4

(1) West Access

Access to area 4 would be from Fall Creek Road along an existing gravel road. This access crosses an existing bridge and terminates onto the channel bottom. The contractor would then navigate across gravel bars and around existing vegetation.

(2) East Access

The east portion of area 4 would be accessed from the Federal Levee Extension. Construction equipment would leave the public highway, approximately 4 miles to the north, and follow the left bank to the Federal Levee Extension to the work area.

c. Area 9

(1) West Access

Of the four areas, area 9 is the most accessible. Access for the west portion of area 9 would come from State Highway 390, from which, the contractors would follow an existing dirt road to the Right Bank Federal Levee.

(2) East Access

Access to the east portion of area 9 would be from State Highway 22, which provides access to the Left Bank Federal Levee. From the Left Bank Federal Levee, the contractor could select an access point to the specific work areas.

d. Area 10

(1) West Access

Most of the work in area 10 lies to the west of the river and would be accessed via the Right Bank Federal Levee. From the levee, construction equipment would traverse across existing gravel bars and through brush to the specific work areas. Equipment could reach the levee from both the upstream and downstream directions. The downstream end of the levee would be accessed from a dirt road that runs for about three-fourths of a mile from State Highway 390 to the Right Bank Federal Levee.

(2) East Access

The work on the east portion of area 10 would be reached from the downstream direction or the upstream direction. From the downstream direction, equipment would travel from State Highway 22 and up the Left Bank Federal Levee for approximately 3 miles to the work areas. From the upstream direction, equipment would travel from Cattleman's Bridge, which is approximately 2 miles away, to Hanson Levee. The spur dikes located to the north would be accessed from Spring Gulch Road, which is about 2 miles away.

Stockpiling of Materials and Staging Areas

Some excavated materials will be temporarily stockpiled on the work sites during the sorting operation. All materials stockpiled onsite would be removed by the end of the current work window. The contractor will be responsible for off-site stockpiling of excavated materials. Excavated material would be stockpiled off-site at a permitted processing facility.

Equipment staging areas will have to meet State and Federal standards for hazardous waste spill containment. Equipment may be staged on-site or off-site depending on environmental conditions. No equipment can be parked on-site past the end of the current work window. The Corps in conjunction with Teton County Natural Resource District personnel would work to locate and setup equipment staging areas whether on or off-site. Any damage or noxious weed infestations caused by equipment use will be mitigated by appropriate restoration or weed control techniques.

Basic Construction Schedule

It is anticipated that one area would be developed per work season. There would be up to two years between construction of structures in one area and the work in the next area of priority. Work is expected to progress over four to eight years.

Yearly Maintenance of Structures

Once work is completed at each area, yearly maintenance will be needed to maintain the integrity of the structures. Maintenance responsibilities have yet to be determined between the Corps and the sponsor. Maintenance will be variable depending on the river/debris flows in any particular year. Maintenance could be performed on any structure which is constructed as part of this project. The maintenance may be as little as replacing a few pieces of fabric and tightening cables

on a brush fence. The maintenance may require total reconstruction of the structure Sediment traps will also have to be cleaned out periodically. Spur dikes, rock grade control, and channel excavations are the only work described that are expected to need little or no maintenance. The maintenance performed on the other structures will have to be scheduled on a yearly basis. Depending on availability of funds and the level of damage, maintenance work would target those structures that are providing the highest benefit for protection/enhancement. At a minimum, those structures which are damaged and creating a safety hazard would be of highest priority for repair or removal. A biologist would also be needed to monitor and direct certain maintenance activities to insure the activity is not degrading existing habitat or disturbing wildlife species which may also be present.

Listed Species and Effects

The following species list was obtained from the U.S. Fish and Wildlife letter dated June 18, 1998. The discussion is based on the above letter, personnel observations during a site tour on July 7 and 8, 1998, and personal communications with Pat Deibert (USFWS), Rik Gay (Teton County Conservation District), Rob Gipson, and John Keifling, fish biologists (Wyoming Fish and Game Department), Dave Moody, wildlife biologist (WGFD) and the wildlife biologists at the Jackson Office WGFD. The following references were also used:

Corps of Engineers, Walla Walla District, 1994, "Jackson Hole Flood Protection: Levee Access Improvements, Draft Environmental Assessment."

Corps of Engineers, Walla Walla District (1992) Draft "Bald Eagle Management Plan, Jackson Hole Project, Wyoming."

Corps of Engineers, Walla Walla District, 1990, "Jackson Hole, Wyoming, Flood Protection Project: Final O&M Decision Document and EIS."

Federal Threatened and Endangered Species Listing for Area

1. Grizzly Bear (Ursus arctos horibilis)
2. Gray Wolf (Canus lupus)
3. Whooping Crane (Grus americana)
4. Bald Eagle (Haliaeetus leucocephalis)
5. Peregrine Falcon (Falco peregrinus)

Discussion of Alternatives

No Action

If the described work is not performed, the riverine corridor will continue to degrade. The presence of the levee system has already degraded the habitat value of the river corridor and associated wetlands. Not only has the river corridor between the levees degraded, the wetlands that used to be associated with river flooding dynamics have been isolated. This isolation has caused a reversion to upland forest types and meadow grasses. For endangered species, several direct impacts have been realized. The loss of mature riparian forest has reduced the nesting and roosting habitat for bald eagles. The loss of wetlands has resulted in the loss of habitat that may have been used by whooping cranes during migration.

Proposed Alternative

The restoration work presented here is an ambitious undertaking for restoration projects of this kind. The work being proposed will not solve all of the ecological problems caused by the levees. The proposed work will be addressing only restoration work within the riverine corridor. If the proposed work is successful in reestablishing riparian vegetation at the chosen locales, bald eagle habitat will definitely be improved. The other listed species will only gain marginal benefits if any. The proposed work, if successful, will provide a spring board for future projects of this type in the region. Some of this future work will address the restoration of wetlands which will improve the potential habitat for migrating whooping cranes.

The restoration work has been divided into four alternatives based on construction materials used. All alternatives will have maintenance performed to keep them in place for the 50 year life of this project. Some alternatives may require more maintenance than others. Since there are no previous examples of this work to compare to, it is difficult to discuss the outcome of one alternative over another. The work as discussed above will be performed as stated. The maintenance could involve all work areas no matter which alternative is chosen. The discussion below will address the work and the maintenance as a part of the proposed alternative no matter which materials are used.

Discussion of Work and Impacts to Species Listed Above

Basic Work Constraints

The engineering document and discussion on site made it clear that most work will only be accomplished during low flows. The reason for this is that the access to the work areas in the river with heavy equipment will only be possible when flows are low enough to cross side channels when they have little or no water flowing in them. Another reason is the depth of the excavations will be dependent on the level of the river at low flow. All of the excavations except for the sediment traps, spur dikes and

channel excavations will occur in areas which are dry or almost dry. Work on sediment traps, spur dikes and channel excavations can only occur when river levels are at their lowest, to facilitate the construction of temporary water diversions, to minimize the amount of silts being released into the stream.

River flows in this region will peak late spring and early summer depending on temperatures, and snow pack depth. Flows can change quickly during the summer with thunderstorm activity in the region. Thunderstorm activity generally lessens in late August when daytime high temperatures are lower. Mountain snow fields cease to melt at this point. This pattern usually causes river levels to drop by mid-summer. Generally, low flows can occur as early as late August, but depending on weather conditions, can occur as late as mid-October. The first significant snows usually start about mid-October. Snow depths can vary from this point on into winter depending on storm intensity. Work will be difficult in deep snow and will probably have to stop by Thanksgiving. For these reasons most work will be restricted to late summer and fall.

Existing tree and shrub removal will be kept to a minimum and avoided where ever possible. Most of the work in the trees is in conjunction with channel enhancement, pond excavation, brush fence construction, and placement of logs. Access into the sites will use existing channels where only downed trees and other flotsam will be removed. Although some trees and brush are likely to be damaged or removed by the work activity it is not recommended to try and replant these trees and shrubs. The work being performed in these areas is done to open channels, the disturbed areas should quickly revegetate naturally. Another reason for not planting is survival during the first year will be very low. The work itself is supposed to augment natural regeneration of the islands and bars in the work areas. The areas which already have vegetation will have sources for natural propagation through seeds or vegetative means. The equipment being used will take what ever precautions necessary to insure they are not picking up noxious weeds and spreading them to the work areas. Monitoring of work areas will be needed the first year after construction to insure noxious weeds are not present. These weeds will need to be eradicated if found.

Maintenance work would also have to follow this approximate schedule if heavy equipment were needed. Other repair could be accomplished when the structures were exposed at lower river flows. Work on brush fences may be accomplished at any time the fence is accessible by foot or ATV.

Threatened and Endangered Species

Grizzly Bear

The grizzly bear is a resident species to the area, primarily north of the Jackson Hole area. Current management in Wyoming (WGFD) is to discourage grizzly bears from living in areas of human habitation. The last siting of grizzly bears in the Jackson area was in 1994. An adult female with 3 cubs of the year were captured near the Ford property and relocated to an area north of Jackson Hole. The female was attracted to the area because 15 cows, which were killed by lightning, were buried on a site near the Ford property. The biggest concern with this species is attracting them to the Jackson area. The chances a bear will be seen on site would be very rare but precautions are needed since late summer/fall is the time of highest bear activity as they search for food, in preparation for hibernation. Workers should be directed not to leave food and other garbage on site that may attract bears to the area. Some of these stipulations could include keeping the work site free of food and garbage, and storing trash and food in approved containers. If a grizzly bear is seen during work activities, Wyoming Fish and Game and US Fish and Wildlife personnel will be contacted. Since there is only a slight chance of human-grizzly bear encounters the proposed work is unlikely to have an impact on the grizzly bear population.

The grizzly bear will not see direct benefits from the work since the Jackson Hole area has a relatively high human population. Whether the work is successful or not, grizzlies which enter and stay in the area will continue to be relocated. The fisheries benefits will improve the overall health of the river system, which may help the bears indirectly.

The long term maintenance of these structures should not have any impact on the grizzly bear. With the management status and nature of the grizzly bear, the added human disturbance is unlikely to directly impact the bear. Maintenance work would have to follow the same stipulations for the project work regarding food and garbage. If a grizzly bear is seen during maintenance work activities, Wyoming Fish and Game and US Fish and Wildlife personnel will be contacted.

Gray Wolf

Gray wolves are not habitat dependent. They might move through the area in search of food, but the chances of this occurring is very rare. No confirmed sightings have been documented in the area around Jackson. The nearest sightings were recorded in the upper Green River drainage east of Jackson. For these reasons it is unlikely the project will have any impacts on local wolf populations. If a gray wolf is

seen during work activities, Wyoming Fish and Game and US Fish and Wildlife personnel will be contacted.

The gray wolf is considered an experimental population. Like the grizzly bear, management provisions have been made to address conflicts with humans or human activities such as ranching. The Jackson Hole area would be an area where human-wolf encounters would be discouraged. The wolves would use the riverine corridor to travel through the area. Whether the work is successful or not, gray wolves which enter and stay in the area will be relocated. With the limited amount of restoration, the project is unlikely to provide any additional benefits for the wolf population as a whole.

The long term maintenance of these structures should not have any impact on the gray wolf. With the management status and nature of the wolf, the added human disturbance is unlikely to directly impact the wolf. The wolves may learn to avoid the area due to the human activity. If a gray wolf is seen during maintenance work activities, Wyoming Fish and Game and US Fish and Wildlife personnel will be contacted.

Bald Eagle

The bald eagle is the only avian species listed which has nesting habitat in the work area. Bald eagles are known to nest in areas 4, 9 and 10. They also nest in the vicinity of area 1. Nesting usually occurs from February through August.

In area 1 a bald eagle nest has been mapped, in the past, toward the north end of the trees on the east side of the channel. No active nests have been located in this area this year.

Bald eagles are nesting near area 4. Two active nests are located on the east side of the river. One nest is located about 2 1/2 to 3 miles south of the Wilson Bridge, 50 yards outside the levee. The second nest is about 1 1/2 miles south of the first nest, three to four hundred yards outside of the levee. Both nests are on the Ford property.

Bald eagles are nesting near area 9. The nest is located on the west side of the river, outside of the levee, near human habitation.

Bald eagles are nesting near area 10. The nest is in a grove of trees on the north side of the Gross Venture river near the mouth. Both eagles were spotted during our tour.

The letter received from the U.S. Fish and Wildlife Service stated that "no work activity within one mile of any active nests would occur between February 1 and August 15th." For this reason, work will only be allowed within one mile of active nests (current year) from August 16th to January 31st. Changes to this work window must have prior approval from the U.S. Fish and Wildlife Service. No other constraints have been applied to nesting bald eagles. Since it is still unknown when work will actually commence, the project area will have to be surveyed for bald eagle nests, each spring of the year when work is to be performed.

Due to the equipment access restrictions stated under work constraints, construction and excavation activities should not conflict with nesting. All standing mature trees in the work area will be avoided if at all possible. Trees which are leaning or already on the ground may be moved aside to facilitate excavation and construction. All of the known eagle nesting trees are currently located outside of the levee system. The biologist onsite will work with the contractor to avoid areas where equipment could damage mature trees.

Bald eagles will also be wintering in the area as long as there is a food source. The biologist on site would monitor for the presence of eagles and provide guidance to the work crews to avoid activities which might disturb the eagles. It is not anticipated that the work activity will cause additional disturbance to the eagles, using the area, beyond the human disturbance already occurring through normal recreational use.

Bald eagles are likely to be found in or near the work area most of the year. The chances of the project having any impact on the bald eagle are minimal due to the timing of the active work. There will likely be no direct impacts (mortality, loss of nest, etc.) or long-term population impacts (reduced reproduction, etc.). There may be some minor displacement to foraging or roosting eagles. For these reasons the project work *May Affect But Is Not Likely To Adversely Affect* bald eagles using the area.

If the project is successful and riparian vegetation can reestablish, bald eagle nesting and roosting habitat will improve. These benefits will not be realized for 30 to 50 years when new cottonwood trees reach maturity. This will be offset somewhat by the continuing maintenance activities which will occur on a yearly basis. The main impact will be the added human activity. The timing/buffer zone of the maintenance work will be similar to the project work. This should alleviate impacts to the nesting population. The added human activity may cause eagles to avoid the area for foraging during ongoing maintenance activities. The biologist on site would monitor for the presence of eagles and provide guidance to the contractor to avoid activities which might disturb the eagles. For this reason the maintenance work will likely have no direct impacts (mortality, loss of nest, etc.) or long-term population impacts (reduced reproduction, etc.). There may be some minor displacement to foraging or roosting

eagles. For these reasons the maintenance work *May Affect But Is Not Likely To Adversely Affect* bald eagles using the area.

Whooping Crane

Whooping cranes do migrate through the area of Jackson Lake during early spring. The birds are migrating through the area to Gray's Lake and will stop briefly at Jackson Lake. There is a chance a whooping crane may stop along the river in the Jackson area, especially if sandhill cranes are using the area. The chances of a whooping crane stopping in the work area would be extremely rare. The cranes would be attracted to wetland pastures and not the riverine corridor between the levees. The confluences of Blue Crane and Fish Creeks are the only two areas which might attract cranes. Most of the work will be taking place between August 15th and November 15th because of concerns with bald eagle nesting and big game migration. For these reasons the project will have no impacts on the whooping crane population.

There is a small chance that a whooping crane could land and feed in the riverine corridor in spring. If a whooping crane is seen during work activities, *work will cease.* Wyoming Fish and Game and US Fish and Wildlife personnel will be contacted. Work will resume only after USFWS personnel have been consulted on how to proceed.

If the project is successful the whooping crane habitat will not benefit from the vegetation growth derived from this work. If the work leads to future restoration in the area, then wetland habitats outside of the levee may improve which will benefit whooping cranes. The ongoing maintenance work will be occurring at the same time as the project work (summer-fall). For this reason the maintenance work should have no impact on the whooping crane population.

If a whooping crane is seen during maintenance activities, *work will cease.* Wyoming Fish and Game and US Fish and Wildlife personnel will be contacted. Work will resume only after USFWS personnel have been consulted on how to proceed.

Peregrine Falcon

Peregrine falcons are residents and migratory to the area. Two known eyries are located in the vicinity of the Grand Tetons. Peregrines do use the river corridor for foraging. Currently, one peregrine forages in the South Park area near Fish Creek. This area is near the west side of area 4. Peregrines will leave the region soon after nesting is complete.. The timing of nesting is similar to that of the bald eagle. They could be in the area any time between February and August. The biologist on site

would monitor for the presence of falcons and provide guidance to the contractor to avoid activities which might disturb the falcons.

Since the bulk of the project work will occur after nesting season, the chance of the project impacting the foraging of peregrines would be minimal. For this reason the project work *May Affect But Is Not Likely To Adversely Affect* peregrine falcons using the area.

If the project is successful, the peregrine falcon will not realize any direct benefits. The falcon could see indirect benefits if passerine bird populations increase as a result of the new vegetation growth. This will be offset somewhat by the yearly maintenance activity needed to maintain the protective value of the construction work. Since most of the maintenance work will occur after nesting season, the chance of the maintenance work impacting the foraging of peregrines would be minimal. For this reason the maintenance work *May Affect But Is Not Likely To Adversely Affect* peregrine falcons using the area.

Conclusion

Based on the above lack of anticipated negative impacts, it is determined that the above described actions *"May Affect But Is Not Likely To Adversely Affect"* bald eagles and peregrine falcons use of the area or their habitats. The described action will have no effect on gray wolves, grizzly bears, and whooping cranes use of the area or their habitats.

If you have any questions or desire additional information about the proposed action, please contact Mr. Scott Ackerman at 509-527-7272.

Sincerely,

Peter F. Poolman
Chief, Environmental Compliance Branch

ACKERMAN/PD-EC/ss

SA

~~SMITH~~/OD-RF (R)

~~MACDONALD/PM~~

CANNON/PD

POOLMAN/PD-EC PAS

PD-EC FILES

Copy Furnished:

CENWW-OD-RF (Smith)

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Ecological Services
4000 Morris Avenue
Cheyenne, Wyoming 82001

ES-61411
pd/WY1782/tcnrdwallacoe.pd

June 18, 1998

Mr. Carl Christianson
U.S. Army Corps of Engineers
Walla Walla District
201 North Third Avenue
Walla Walla, Washington 99362-1876

Dear Mr. Christianson:

Thank you for your letter of May 21, 1998, for the Snake River riparian and restoration project in Teton County, Wyoming.

In accordance with section 7(c) of the Endangered Species Act of 1973, as amended (Act), my staff has determined that the following threatened or endangered species may be present in all project areas.

Species	Status	Expected Occurrence
Bald eagle (*Haliaeetus leucocephalus*)	Threatened	Nesting. Winter resident. Migrant.
Peregrine falcon (*Falco peregrinus*)	Endangered	Nesting. Migrant.
Whooping crane (*Grus americana*)	Endangered	Resident. Migrant.
Gray wolf (*Canis lupus*)	Experimental (Formerly Endangered)	Potential resident.
Grizzly bear (*Ursus arctos horribilis*)	Threatened	Resident.

There are bald eagle nests located in project areas 1 and 10. Therefore, all activities associated with areas 1 and 10 should not occur until after August 15 and be completed by February 01 to prevent disturbance to these nests. Bald eagle nests are also adjacent project areas 4 and 9. All activities associated with these areas that are within one mile of an active bald eagle nest must also be restricted to the time period specified above. If it is determined that the proposed

We are planning a site visit and complete analysis of this project area this upcoming summer. At that time, we may have additional recommendations which we will immediately forward to your office. If you have any questions please contact Pat Deibert of my staff at the letterhead address or phone (307) 772-2374.

Sincerely,

Mary E Jennings

for Michael M. Long
Field Supervisor
Wyoming Field Office

cc: Director, WGFD, Cheyenne, WY
Nongame Coordinator, WGFD, Lander, WY

APPENDIX B

COORDINATION ACT REPORT

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Ecological Services
4000 Morrie Avenue
Cheyenne, Wyoming 82001

ES-61411
pd/W.06/snakecar.pd

October 27, 1998

Mr. Carl J. Christianson
Chief, Environmental Planning Branch
Department of the Army
Walla Walla District, Corps of Engineers
201 North Third Avenue
Walla Walla, Washington 99362-1876

Dear Mr. Christianson:

We have reviewed the Corps' comments on the final Coordination Act Report for the Snake River Environmental Restoration Project, and modified the report based on those comments. Enclosed is the revised final Fish and Wildlife Coordination Act Report for the proposed project. The report was completed pursuant to the scope of work dated April 17, 1998, and prepared under the authority, and in accordance with the provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S. C. 661 et seq.).

We look forward to continuing our work with the U.S. Army Corps of Engineers on this project. If you have any questions on this report please contact Pat Deibert of my staff at (307) 772-2374, ext. 26.

Sincerely,

Michael M. Long

Michael M. Long
Field Supervisor
Wyoming Field Office

COORDINATION ACT REPORT
Snake River Restoration Project

The U.S. Fish and Wildlife Service has reviewed the proposed Snake River Environmental Restoration Project, a proposal to provide ecosystem restoration to four areas on the Snake River between Moose and the South Park Feed Grounds near Jackson Hole, Wyoming. This report has been prepared under the authority, and in accordance with the provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S. C. 661 et seq.).

Project Description:

The Snake River in the Jackson area is confined by levees constructed and maintained by the Snake River Flood Control Project (U.S. Fish and Wildlife Service 1990). Concentration of the river flows by the levees has caused extensive erosion, resulting in loss of aquatic and terrestrial wildlife habitat. Fish and wildlife impacts resulting from construction, operation and maintenance of the Flood Control Project have significantly changed the character of the Snake River ecosystem (U.S. Fish and Wildlife Service 1990). The goal of this restoration project is to provide environmental and wildlife habitat restoration of riverine, wetland and riparian habitats within four selected study areas. To accomplish this goal, stability of the channel will be increased and frequency of island removal/destruction will be decreased to allow maturation of vegetation on forested islands and re-vegetation of denuded islands. This project is proposed by the U.S. Army Corps of Engineers, with cooperation of the Teton County Natural Resource District.

Four areas have been selected for restoration. Area 1 is located in sections 13, 14, 23 and 24 of Township 40N, Range 117W; Area 4 is located in sections 2, 3, 10 and 11, Township 40N, Range 117W; Area 9 is located in sections 13 and 24, Township 41N, Range 117 W; and Area 10 is located in sections 5,6 and 7, Township 41N, Range 117W (Figure 1). All sites are in Teton County, Wyoming.

Area Description:

The vegetation in the four project areas is characterized by shrub willow (*Salix* ssp.)/cottonwood (*Populus* ssp.) riparian communities supported by the natural hydrology of the river system. Other species common within the floodplain and on islands include Englemann spruce (*Picea englemannii*) and blue spruce (*Picea pungens*), silverberry (*Eleagnus commutata*), alder (*Alnus incana*), Wood's rose (*Rosa woodsii*), buffalo berry (*Sherpherdia canadensis*) and honeysuckle (*Lonicera involucrata*) (U.S. Army Corps of Engineers 1994). Installation of levees has reduced the quantity of the riparian habitat within the levees from 2,761 acres in 1956 to 1,176 acres in 1986. The quality of the remaining riparian habitat has also declined (U.S. Fish and Wildlife

Service 1998). The area of cottonwood forest behind the levees has remained approximately constant between 1956 and 1986, but the quality of this habitat has been reduced. The percent of mature cottonwoods has increased behind the levees, indicating that cottonwood regeneration has declined. There has also been a 149 percent increase of cottonwood-spruce habitat from 1956 to 1986 behind the levee indicating a loss of riparian habitat. The loss has been compounded by the side channels and spring creek habitats being cut-off from the river by the levees (U.S. Fish and Wildlife Service 1998).

Area 1 is the only area not bounded by levees along both banks. Within the past few years the west bank has undergone extensive lateral erosion due to the "firehose"effect of concentrated river flows emerging from the confined channel upstream. Greater than 300 acres of pastureland have been lost from this erosion. Vegetation in this area is a combination of shrub willows/cottonwoods on the shore line with some cottonwoods on an existing island. However, these cottonwoods are in danger of removal from high river flows. Surrounding land use is ranching and rural residential.

The vegetation around Area 4 is predominantly shrub willow. Most of the existing islands currently within the channel are void of vegetation due to island instability and changing river flows. This area is bordered by a developing subdivision on the west side. The Jackson Land Trust has obtained an easement on many of the lots within this subdivision for the protection of trumpeter swan wintering and feeding habitats (D. Stevenson, WGFD, pers. comm.). The surrounding land use is rural residential.

Area 9 is bounded by Highway 22 to the south and contains a boat ramp on the west bank used extensively by recreational boaters and outfitters. Vegetation in this area is predominantly shrub/willow, with some mature cottonwoods on an existing island. Surrounding land use is light business, transportation and rural residential. A portion of this area has been selected as a demonstration area to test the proposed restoration techniques. Restoration efforts, to be implemented by Teton County Natural Resource District, are scheduled to begin in the Fall of 1998.

Area 10 is located at the confluence of the Gros Ventre and Snake Rivers. This area has extensive cottonwood vegetation on existing islands and along the shoreline. However, some of the island vegetation was removed by high spring flows in 1998. Surrounding land use is rural residential.

Restoration Techniques:

Several methods are proposed to accomplish the proposed restoration including gravel removal, anchored root wads, brush fences, spur dikes and rock grade control. Table 1 outlines the techniques proposed for use by area. According to personal communications with Teton County Natural Resources District and U.S. Army Corps of Engineers personnel, all construction is

proposed to occur during low water flows in September through early November. Annual maintenance of restoration features may be necessary to maintain their protection/enhancement capabilities.

TABLE 1: Restoration treatments proposed by project area.

TREATMENTS

	Gravel Removal			*Fences*	*Dikes*	*Root Wads*	*Rock Grade*
	Channel Capacity	Side Pools	Sediment Traps				
Area 1		X	X	X		X	
Area 4	X	X	X	X	X	X	
Area 9	X	X		X	X	X	X
Area 10	X	X	X	X	X	X	

Gravel Removal
Confinement of the Snake River within levees has resulted in areas of unusually high gravel deposition and reduced channel capacity. Removal of excess gravel from these areas will improve fish habitat (by creating resting areas in side pools), maintain channel capacity, increase channel stability and improve sediment transport. Removal would be accomplished with excavators, loaders, dump trucks and grizzlies. The Wyoming Department of Environmental Quality has not yet made the determination on whether or not construction equipment can be operated in flowing water. If construction equipment is not permitted to operate in flowing water temporary diversion dikes will be necessary. Material for these dikes would be from existing riverbed material (U.S. Army Corps of Engineers 1998). Gravel removal in should not occur in side channels to prevent fish entrapment during low water levels.

Brush Fences
Brush fences will be used to help re-establish island riparian habitat and to protect existing island habitat by slowing water velocities and reducing the energy of water flows. Rock grade control structures would be used in conjunction with brush fences in Area 9 to prevent channel down-cutting. Brush fences may be constructed using piling with lateral cables, or with riprap (rock brush fences). Piling brush fences would be constructed by excavating along the fence alignment and driving piles into the river bottom with vibratory hammer mounted on a backhoe. Rock

brush fences will be constructed by excavating a trench to a depth of 4 feet. The trench site would be filled with riprap material of sufficient size to resist removal from high flows. Small materials from the excavation would be hauled off-site (U.S. Army Corps of Engineers 1998).

Spur Dikes

Spur dikes will be used for fisheries habitat enhancement and bank protection. These dikes will create flow diversity and enhance pools, fish resting areas, riffles and seams (U.S. Army Corps of Engineers 1998). Two kinds of spur dikes may be used: kicker dikes and bank barbs. Kicker dikes will be composed of riprap armor with a random fill core and will extend 56 feet into the river. Bank barbs will consist only of riprap and extend 26 feet into the river. Riprap material will be hauled to the dike location with dump trucks (U.S. Army Corps of Engineers 1998).

Anchored Root Wads

Root wad logs would be anchored into the river bottom to protect existing islands and to encourage growth of new islands. On-site root wad logs will be the primary source of this material. If a secondary source is required, this source will be designated by a Corps representative. Installation of the root wads may require leveling of the area by a backhoe. Logs will be fastened with toggle bolt anchors driven in to the ground with a jackhammer (U.S. Army Corps of Engineers 1998). Root wads will not be placed in the lower reaches of Blue Crane or Spring Creek to ensure these areas remain accessible as spawning tributaries.

Rock Grade Control

A rock grade control structure will be used to keep the river from eroding through existing riparian habitat. The rock grade control structure will consist of riprap and will be flush with the existing channel bottom. The footprint of the structure would be excavated and material hauled off-site. Riprap would be placed in the excavation area by carefully keying riprap together (U.S. Army Corps of Engineers 1998).

Access

Access to the western side of Area 1 would be via the existing Fall Creek Road and associated dirt roads. Access would also be provided on levee roads. However, the exact location for river access by heavy equipment, etc. has not been determined at this time. Access to the east side of Area 1 would be along existing roads to levees until the levee terminates. After the levee ends, access would continue through existing shrubs and trees over gravel bars. The exact route taken will be determined by the Corps and will be selected to minimize disturbance to the riparian community.

Access to the western side of Area 4 would be from the existing Fall Creek Road and an associated gravel road. At the road termination, the operator will need to navigate across gravel bars along the channel bottom. Access to the eastern side of this area will be from the Federal Levee Extension. This proposed access is still under negotiation with the adjacent landowner and may change.

Western access to Area 9 would be via State Highway 390 to an existing dirt road and along the right Bank Federal Levee. Eastern access to this area will be from State Highway 22 to the Left Bank Federal Levee. From this levee, the contractor will select access points for specific work areas.

Access to the western side of Area 10 would be via the Right Bank Federal Levee. From the levee, construction equipment will traverse across existing gravel bars and through brush to specific work areas. Eastern access to this area will be via State Highway 22 to the Left Bank Federal Levee or from Cattleman's bridge to the Hanson Levee. The spur dikes located to the north will be accessed from Spring Gulch Road.

Alternatives

Five alternatives are proposed - no action, and four structural alternatives designed to withstand differing intensities of flood events. The structural alternatives include designs to withstand a 15-year flood event, a 25-year flood event and two designs to handle a 50-year flood. Potential impacts of these alternatives are discussed in the following Project Impacts sections. The final preferred alternative will be selected based on incremental benefit analysis.

Fish and Wildlife Resources - Existing Condition

Aquatic Resources

Within the four project areas, the Snake River is designated as a Class 1 trout fishery as designated by the Wyoming Game and Fish Department. This designation signifies the River is of national importance as a trout fishery. This fishery is composed primarily of Snake River cutthroat trout (*Oncorhynchus clarki* ssp.). Other game fish present include mountain whitefish (*Prosopium williamsoni*), brown (*Salmo trutta*), brook (*Salvelinus fontinalis*), rainbow (*Oncorhynchus mykiss*) and lake trout (*Salvelinus namaycush*). Non-game fish include the Bonneville redside shiner (*Richardsonius balteatus*), speckled dace (*Rhinichthys osculus*), longnose dace (*Rhinichthys cataractae*), Utah chub (*Gila atraria*), leatherside chub (*Gila copei*), Utah sucker (*Catostomus ardens*), bluehead sucker (*Catostomus discobolus*), mountain sucker (*Catostomus platyrhynchus*), mottled sculpin (*Cottus bairdi*) and Paiute sculpin (*Cottus beldingi*) (U.S. Fish and Wildlife Service 1990).

Spawning habitat for the Snake River cutthroat trout is considered one of the major factors limiting population for this species in the upper Snake River drainage. Spawning is limited to spring-fed tributaries. Little or no spawning habitat exists in the main river because high flows, particularly during spring run-off, produce large sediment bed loads and turbidity during the

spawning period. Habitat losses of spawning habitat have occurred from human activities, including diversions for irrigation and levee construction (U.S. Fish and Wildlife Service 1990). Mountain whitefish are very abundant within the project area and prefer fast, deep water. They

are also commonly found in riffle areas in the summer. The Snake River and its tributaries are major spawning areas for this species (U.S. Fish and Wildlife Service 1990). Spawning occurs in September and can continue through November. Non-game fish in this system provide important forage for game fish and fish-eating raptors in the area.

Terrestrial Resources - Avian

Over 150 different species of birds have been observed along the Snake River corridor. Of those, 119 are documented breeders. Seventy-nine percent of the area's breeding birds are associated with the cottonwood-riparian and wetland habitat types found along the Snake River. Many species also congregate and use the area for feeding and resting during spring-fall migration (U.S. Fish and Wildlife Service 1990).

Of the total number of bird species identified, approximately 75 percent are passerines (Table 2). Nearly 65 percent of those birds are probable or documented breeders in this area indicating the value of the riparian habitat to this group. No threatened or endangered passerines, or passerines classified as State species of special management concern occur in any of the project areas (Wyoming Game and Fish 1996, 1997).

All raptors documented within the area breed there (Table 3). Two species, the osprey (*Pandion haliaetus*) and bald eagle (*Haliaeetus leucocephalus*) obtain their primary food (fish) from the Snake River. Ospreys are very common in the Jackson area. The Snake River and tributaries provide large amounts of foraging habitat for this raptor because of abundant fish populations (U.S. Fish and Wildlife Service 1990).

Active bald eagle nests occur in close proximity of all four project areas. This species is currently listed as threatened by the U.S. Fish and Wildlife Service, and as a Native Species Status 2 by the Wyoming Game and Fish Department due to on-going significant habitat loss within the State. The bald eagle nest at Area 1 is approximately 300 to 400 yards inland from the eastern river bank (and proposed restoration work). This pair is inconsistently successful in producing fledgings from this nest (D. Stevenson, WGFD, pers. comm.) At Area 4, the bald eagle nest is approximately 50 yards from the eastern levee (and the proposed restoration work). This nest has been consistently productive. The nest at Area 9 is just north of the project area in section 13 and is in close proximity of a restaurant and other high disturbance areas. This nest has been consistently successful despite the disturbance. The nest at Area 10 is along the Gros Ventre River just upstream from its confluence with the Snake River. This pair often relocates their nest annually, but typically uses locations on the Snake and Gros Ventre Rivers within the

proposed restoration area (D. Stevenson, WGFD, pers. comm.). The bald eagle population in the Greater Yellowstone Ecosystem is considered one of the most important breeding populations in the Rocky Mountains and has been increasing since the 1970's. The Snake River unit of this population contributes significantly to current recovery trends of the bald eagle in this region (U.S. Army Corps of Engineers 1994). Both bald eagles and osprey commonly use snags and large living trees for nesting and roosting. Declines of this habitat component are occurring due to hydrologic changes as a result of levee construction (U.S. Army Corps of Engineers 1994).

Two peregrine falcon (*Falco peregrinus*) aeries occur within 15 miles of the proposed restoration areas. Although the restoration project will have no direct impact on these aeries, the adults from these nests often forage within the project areas, particularly Areas 1 and 4 (D. Stevenson, pers. comm.). This species is currently classified as endangered by the U.S. Fish and Wildlife Service, and as a Native Species Status 3 species by the State of Wyoming due to restricted habitat availability and declining populations (Wyoming Game and Fish Department 1996).

Resident and migratory waterfowl use the Snake River and its tributaries for spring/fall staging, breeding, nesting, brood rearing and wintering habitat (Table 4). Trumpeter swans (*Cygnus buccinator*) winter on the Snake River near all four project areas. Winter is a critical time for this species due to decreased availability of habitat and increased competition with other waterfowl species for food (U.S. Army Corps of Engineers 1994). Fish Creek, which flows along the western side of the Snake River near Areas 1 and 4 provides important feeding and wintering habitat for this species. Swans also use the Gros Ventre River at its confluence with the Snake River (Area 10) for feeding and wintering (D. Stevenson, WGFD, pers. comm). However, this species does not nest along the Snake River. The trumpeter swan is classified as Native Species Status 2 by the Wyoming Game and Fish Department, indicating special management efforts are warranted due to on-going significant loss of habitat (Wyoming Game and Fish Department 1996). Other common waterfowl species in this area include the Canada goose (*Branta canadensis*), mallard (*Anas platyrhynchos*), American wigeon (*Anas americana*), green-winged (*Anas crecca*) and blue-winged teal (*Anas discors*), common goldeneye (*Bucephala clangula*), Barrow's goldeneye (*Bucephala islandica*) and ring-necked duck (*Aythya collaris*).

Common loons (*Gavia immer*) use the Snake River, including the project areas, as a resting stop during the spring migration. This species is classified as Native Species Status 1 by the State of Wyoming in recognition of declining populations and on-going significant habitat loss (Wyoming Game and Fish Department 1996). American white pelicans (*Pelecanus erythrorhynchos*) also use the Snake River in and near the project areas, particularly Areas 1 and 4, for foraging. These birds typically leave the river by late summer (D. Stevenson, WGFD, pers. comm.).

A great blue heron (*Ardea herodias*) rookery is approximately 400 yards from the east bank of the Snake River at Area 1. This species is common in the Jackson area. Most migrate out of the

area in late fall, but there are a few resident birds (U.S. Army Corps of Engineers 1994). The endangered whooping crane (*Grus americana*) occasionally migrates through the project area enroute to Jackson Lake and Grand Teton National Park to the north. However, this species is not common in the project area. Sandhill cranes (*Grus canadensis*) are widely distributed in the

Jackson area and occur primarily in association with wetlands and agricultural fields. This species migrates out of this area by late September (U.S. Army Corps of Engineers 1994).

Terrestrial Resources - Mammals

Four species of big game animals are common along the Snake River corridor near the proposed restoration areas. Areas 1 and 4 provide crucial winter-yearlong range for moose (*Alces alces*) in the Sublette herd management unit and Areas 9 and 10 provide crucial winter-yearlong range for moose in the Jackson herd management unit. Crucial range is defined by the Wyoming Game and Fish Department as habitat necessary to ensure the long-term survival of a population of animals at a desired level. In addition to the above designation, Area 9 is within a migration corridor for moose within the Sublette herd unit. Elk (*Cervus elaphus*) from the Fall Creek herd management unit winter along Areas 1 and 4, but this habitat is not considered crucial. Elk from the Jackson herd management unit migrate through Areas 9 and 10 (J. Bohne, WGFD, pers. comm.).

All four areas provide spring/summer/fall habitat for mule deer (*Odocoileus hemionus*). Areas 1 and 4 provide habitat for deer within the Sublette herd management unit while Areas 9 and 10 provide habitat for deer within the Jackson herd management unit. The east side of Area 10 is designated as crucial winter range for mule deer in the Jackson herd management unit (J. Bohne, WGFD, pers. comm.).

The grizzly bear (*Ursus arctos*) is a resident species to the area, primarily north of the Jackson Hole area. This species is listed as threatened by the U.S. Fish and Wildlife Service. Current management by the Wyoming Game and Fish Department is to discourage grizzly bears from living in areas of human habitation. The last sighting of a grizzly bear in the Jackson area was of a sow and 3 cubs of the year in 1994 near Area 4. The bears were attracted to the area by 15 cows killed by lightening. The bears were captured and successfully relocated to an area north of Jackson.

In 1995, gray wolves (*Canis lupus*) were re-introduced into Yellowstone National Park and the Greater Yellowstone ecosystem. Some wolves have dispersed to areas outside the Park. However, no confirmed sightings have been documented around Jackson, or in the project area. Gray wolves are not habitat dependent, but could potentially move through the area in search of food. All wolves within Wyoming are now considered part of a nonessential experimental population. Although such wolves remain listed and protected under the Endangered Species

Act (Act), additional flexibility is provided for their management under the provisions of the final rule and special regulations promulgated for the nonessential experimental population on November 22, 1994 (59 FR 60252). On any unit of National Park System or National Wildlife Refuge System lands, wolves that are part of the experimental population are considered a threatened species and the full provisions of section 7 of the Act apply. Additional management flexibility is provided for managing wolves existing outside units of the National Park or National Wildlife Refuge System. Wolves designated as nonessential experimental in these areas are treated as proposed rather than listed.

Common furbearers in the project area include the mink (*Mustela vison*), muskrat (*Ondatra zibethicus*), river otter (*Lutra canadensis*) and beaver (*Castor canadensis*). Mink are found in relatively lower densities and prefer riverbottom habitats that provide adequate cover and an abundant food source. Selected prey items include fish, amphibians, birds and various small mammals, fruits and berries. The presence of riprap flood protection levees has created an abundance of denning habitat for this species (U.S. Army Corps of Engineers 1994). Muskrats are a common resident of ponds, oxbows and spring creeks within the project area. They feed primarily on aquatic vegetation. Muskrats are economically important as a furbearer and are annually harvested within and adjacent o the project area.

The Snake River is identified as one of the most significant areas in Wyoming for the river otter. Otters use log jams, pools and oxbows as foraging areas due to the large number of fish which congregate in these areas. Due to the lack of suitable habitat, otters are not common between levees (U.S. Army Corps of Engineers 1994). Beavers are also present in the project areas. They rely heavily on cottonwood trees for lodge and dam construction and prefer vegetation in the willow shrub under story as a food source. Flood control levees have decreased the availability of denning habitat for this species (U.S. Army Corps of Engineers 1994). Prime habitat is found along spring creeks, side channels and oxbows.

A number of small mammalian species use the project area on a permanent, seasonal or transient basis. Populations of small mammals are cyclic in nature with densities varying by season. However, if sufficient habitat is available, small mammal densities are relatively high. The multi-layered herbaceous vegetation provides a diverse habitat for various mammal species found in the area. The masked (*Sorex cinereus*), dusky (*Sorex monticolus*) and northern water (*Sorex palustris*) shrews are documented in the project area and prefer mesic habitats with a source of water nearby. The project area provides an abundant terrestrial and aquatic insect source for shrews. Vole species include the southern red-backed (*Clethrionomys gapperi*), heather (*Phenacomys intermedius*), montane (*Microtus montanus*), meadow (*Microtus pennsylvanicus*), water (*Microtus richardsoni*) and long-tailed (*Microtus longicaudus*) voles. Area riparian habitats supply voles with an abundance of plant material, seeds, fruits and insects for food as well as leaf litter, logs and windfallen trees for security. Deer mice (*Peromyscus maniculatus*) and western jumping (*Zapus princeps*) mice are also found in the cottonwood understory. Squirrels found in the project area include the golden mantled ground squirrel

(*Spermophilus lateralis*), yellow-bellied marmot (*Marmota flaviventris*), red squirrel (*Tamiasciurus hudsonicus*), Uinta ground squirrel (*Spermophilus armatus*) and least chipmunk (*Tamias minimus*). Other small mammals common to the area include the northern pocket gopher (*Thomomys talpoides*), bushy-tailed woodrat (*Neotoma cinerea*), striped skunk (*Mephitis mephitis*), long-tailed weasel (*Mustela frenata*) and porcupine (*Erethizon dorsatum*).

Reptiles and Amphibians

The project areas may provide habitat for the tiger salamander (Ambystoma tigrinum), northern leopard frog (*Rana pipiens*), spotted frog (*Rana pretiosa*), boreal chorus frog (*Pseudacris triseriata maculata*), rubber boa (*Charina bottae*), bullsnake (*Pituophis melanoleucas sayi*), wandering garter snake (*Thamnophis elegans vagrans*) and valley garter snake (*Thamnophis sirtalis fitchi*).

Project Impacts - General

Determining the actual project impacts to terrestrial and aquatic wildlife is difficult given the changing morphology of the Snake River. Engineering plans finalized in the summer of 1998 will likely be changed for some project areas due to the continually changing river structure from high water flows. For example, some islands designated for protection were destroyed by spring flows in 1998, and gravel has been re-distributed in other areas, making changes in the location of gravel removal necessary. Below is a summary of projected impacts to terrestrial and aquatic wildlife. Due to river changes, these descriptions have been kept necessarily general and may be changed if significant engineering changes are necessary for project completion.

Projected Impacts - Aquatic Wildlife

There will be significant disturbance to fishes and aquatic invertebrates due to instream construction activities. The impacts may include direct mortalities, movement disruption and/or temporary habitat displacement. No existing aquatic wildlife resources have been identified as currently being threatened due to limited population size. If the work is completed during the fall, spawning migrations of the Snake River cutthroat trout will not be disrupted. However, spawning activities and redds of mountain whitefish may be disrupted within each project area. These impacts are not expected to significant or long-term (J. Kiefling, WGFD, pers. commun.)

The proposed restoration project was described in the Coordination Act Report drafted for the maintenance of the Snake River levees in 1988 as mitigation for those activities (U.S. Fish and Wildlife Service 1990). If successful, the proposed project will benefit aquatic wildlife, particularly Snake River cutthroat trout, by providing resting areas, channel stability and overhanging vegetation. The proposed project is supported by Wyoming Game and Fish Department. A cutthroat habitat evaluation procedure has been proposed by the Wyoming Game

and Fish Department, with concurrence of the U.S. Army Corps of Engineers, to measure the effectiveness of the implemented restoration measures. This procedure will allow comparison to pre-restoration conditions to assess the effectiveness of the project. In order to adequately assess any impacts or benefits of this project, monitoring will be necessary for a minimum of three years will be. Although this project will assist in restoration of limited areas of fishery habitat, a system-wide solution is still necessary to protect important fish and wildlife resources negatively impacted by continued building of levees along the Snake River. A riparian maintenance plan should be developed by an interdisciplinary team to preserve the diversity and value of this ecosystem.

There should not be significant differences in potential impacts to aquatic wildlife between the four action alternatives. However, displacement and temporary habitat disruption will occur more frequently with the 15-year and 25-year alternatives, versus the 50-year alternatives, due to the increased necessity of repair work on the structures with the shorter expected life spans.

There may be a negative impact to fishing-related recreation within the project areas. Low flows in September and October provide excellent flyfishing opportunities in the Snake River. Many commercial outfitters float through the project areas while providing guided flyfishing tours. The proposed construction activity may disrupt some of these activities. All efforts should be made to inform the outfitters of construction schedules, including daily communications, if necessary. Additionally, river diversions should be designed to allow passage of boats at all times. Given the short duration of construction activities, there should be no long-term impacts to recreational fishing.

Project Impacts - Terrestrial Wildlife

To determine the impacts of project construction on wildlife habitat within the four project areas, the Habitat Evaluation Procedures (HEP) were used to evaluate the quality and quantity of two representative vegetative cover types; palustrine shrub scrub and palustrine forest, including cottonwoods. The palustrine shrub scrub cover type was evaluated using a modification of the yellow warbler (*Dendroica petechia*) HEP model. A modification of the song sparrow (*Melospiza melodia*) HEP model was used to evaluate the palustrine forest habitat. Using HEP, habitat quantity and quality are quantified and multiplied together to produce "habitat units." A comparison of habitat units for baseline and "with project" conditions allows HEP users to quantify project impacts/benefits.

Using estimates of habitat type coverage and quality from 1991 and 1996 uncontrolled aerial photos, field data collected in 1996, and estimates of habitat quantity and quality with restoration efforts, changes in habitat units for these two cover types were projected for 50 years after project implementation. These results are based on the expected habitat changes under both 50-year alternatives. An incremental analysis was subsequently conducted on both the 15- and 25-

year alternatives. Changes in habitat units for a "no action" alternative were also estimated. For the palustrine shrub scrub cover type, the number of habitat units for yellow warblers progressively increased over time after implementation of the proposed project for all four areas. Under the no action alternative, the number of habitat units are projected to decline (Table 5). Similarly, for the palustrine forest the number of song sparrow habitat units also increased progressively over time for all four project areas with the 50-year alternatives after project completion (Table 5). The incremental analysis showed that there would be smaller increases in habitat units under the 15- and 25-year alternatives. The no action alternative resulted in a decrease of habitat units (Table 5). These data also suggest that cottonwood re-generation and retention would be stimulated by implementation of the project.

TABLE 5: Summary of HEP results for each Project Area and Habitat Type. Results are presented for data collected in 1996, projected values 50 years after project implementation (50 Years), and no action (NA).

	Area 1			Area 4			Area 9			Area 10		
Shrub/ Scrub	1996	50 Years	NA	1996	50 Years	NA	1996	50 Years	NA	1996	50 Years	NA
Habitat Units	126.6	318.9	76.1	71.7	98.1	43.5	7.6	13.2	4.4	24.9	45.3	15.0
Acres	384.5	398.7	230.7	105.1	122.6	63.1	10.7	16.5	6.4	37.9	56.5	22.7
HSI Values	0.33	0.80	0.33	0.68	0.80	0.69	0.71	0.80	0.69	0.66	0.80	0.66
Forest												
Habitat Units	1.9	10.4	1.1	37.4	53.4	22.5	5.2	8.2	3.1	26.3	47.9	15.0
Acres	2.8	12.0	1.7	44.1	61.4	26.5	6.0	9.4	3.6	31.3	55.1	18.8
HSI Values	0.68	0.87	0.68	0.85	0.87	0.85	0.87	0.87	0.85	0.84	0.87	0.80

The results of the HEP analyses suggest the proposed work will benefit terrestrial wildlife by restoring riparian habitat. Stabilization of existing and re-generation of new riparian vegetation will ultimately result in an increase in density, and possibly diversity, of terrestrial wildlife. There will be short-lived negative impacts from access routes, staging areas for gravel sorting and heavy equipment storage, reduced air and noise quality and increased traffic. Actual impacts from these associated activities cannot be fully assessed at this time since access routes and

staging areas have not been determined for all sites. However, these impacts should be temporary (occurring during the construction period only) and if mitigated, long-term impacts will be minimal, and more than offset by project benefits.

If the fall construction schedule is followed, impacts to nesting birds, such as bald eagles, ospreys and other raptors, great blue herons, waterfowl, shorebirds and passerines will be minimal. Cottonwood regeneration will result in continued nesting and roosting habitat for ospreys, bald eagles and other raptors, as well as great blue herons. These resources would decline without the project. The fall construction schedule will also eliminate impacts to spring migratory birds, including common loons and whooping cranes. Impacts to peregrine falcons should be minimal since young of the year will have fledged and will no longer be completely dependent on adults foraging within project areas 1 and 4. Trumpeter swans typically move into winter feeding areas in late November to early December. Completion of the project by early November will minimize impacts to trumpeter swans wintering in the area. Some displacement of fall migrants, including waterfowl and sandhill cranes, may occur. However, given the limited size of each project area, sufficient staging and feeding habitats outside the disturbance should still be available.

If all work in each project area is completed by early November, impacts to big game species dependent on these areas should be minimal. Elk, mule deer and moose typically begin to use these areas in mid to late November, depending on early season snowfall amounts. There should also be minimal impacts to animals migrating to and from feedgrounds in the area since these migrations often occur in late November and December, and in April and early May (J. Bohne, WGFD, pers. comm.).

The potential for occurrence of grizzly bears and gray wolves in the project areas is minimal and the project should have no impact on these species. However, every precaution should be taken by the construction crews to ensure grizzly bears are not attracted to the work site. There may be indirect impacts (displacement and temporary habitat loss) to furbearers in the area. However, these impacts should be minimal due to the limited size of each project area. Additionally, any impact to this group should be fully mitigated by the improvement in riparian habitat gained through project implementation. There should be no impacts on furbearer trapping activity since seasons for most furbearers begin after construction is proposed for completion.

There will likely be some direct loss of small mammals and their habitat, as well as associated impacts, such as displacement. However, most of the small mammals in the area have a high reproductive capacity, and long-term population impacts are not anticipated. Additionally, habitat for these species should increase after project implementation. Similarly, there will likely be direct and indirect losses to some reptiles and amphibians. However, long-term population impacts are not anticipated.

Recommendations:

1. Use existing access routes and staging areas where possible. If new access routes must be constructed, the routes should be placed to minimize damage to riparian vegetation and wetlands.

2. All new routes and staging areas constructed for the purpose of this project should be fully mitigated by restoring the natural topography and re-establishing native vegetation. Additionally, no public access should be allowed on new access routes to minimize the possibility that these routes become "established" through use after project completion. These non-public access routes should be properly gated to prevent non-authorized vehicular access.

3. As much as possible, material for construction of brush fences, root wads and kicker/spur dikes should be obtained on-site or from a source certified as disease free. If a secondary source of these items is required, this source should be approved by the Wyoming Game and Fish Department, Fisheries Section, to minimize the chance for fish disease transmission.

4. To protect nesting bald eagles, ospreys, great blue herons and other avian species, as well as migrating whooping cranes and common loons, no construction activities should begin prior to August 15. This includes construction of any new access routes and staging areas, movement of equipment to project areas and long-term survey team activity. Should no bald eagles nest within one mile of the project area, work may begin earlier than August 15 *after* consultation with the U.S. Fish and Wildlife Service. This consultation is necessary to ensure no other nesting migratory birds will be impacted by construction activity.

5. To protect wintering big game and trumpeter swans, all construction activity should be concluded by November 15. This includes removal of all associated equipment. Site visits to these areas after November 15 should be limited to only those absolutely necessary for project administration. If work cannot be completed by this date, or if big game have not begun moving into the area due to fair weather conditions, work may continue after November 15. However, this continuation can only occur *after* concurrence is received by the Wyoming Game and Fish Department.

6. All garbage, including food, should be removed from the project areas daily to discourage grizzly bears from entering the area. Bear proof trash and food storage containers should be provided to construction crews.

7. All construction and associated activities should be restricted to the area between levees to minimize potential damage to spring creeks, side channels and oxbows. For Area 1, all work

should be restricted to the river channel and immediately adjacent bank. Access to Area 1 should avoid damage to all spring creeks and the access route may require approval by a biologist to avoid unnecessary damage.

8. All equipment necessary for instream use should be thoroughly examined and serviced to minimize the potential for discharge of petroleum products into the Snake River. All equipment should be serviced off-site to prevent accidental spills of petroleum products into the River.

9. All activities should be performed in a manner that meets State and Federal water quality standards.

10. Borrow areas, if necessary, should be located outside the riparian corridor and avoid important fish and wildlife habitat.

11. Officials in charge of on-site construction should provide construction schedules by Area to local fishing outfitters. All efforts should be made to keep affected outfitters informed of changes in construction schedules.

12. A monitoring program for all restoration areas should be established to determine the effectiveness of this project. Monitoring should continue for a minimum of 10 years.

13. If annual maintenance of the protection/enhancement structures if necessary, this maintenance should be conducted in late summer to minimize potential impacts to nesting bald eagles, raptors and other migratory birds, and to wintering big game and trumpeter swans. If maintenance must be conducted outside the late summer period, the party responsible must work with either the U.S. Fish and Wildlife Service (bald eagles, migratory birds, raptors) or the Wyoming Game and Fish Department (big game) to ensure the proposed activities will not negatively impact these species.

14. Although this project will assist in restoration of limited areas of fish and wildlife habitat, a system-wide solution is still necessary to protect important fish and wildlife resources negatively impacted by levees along the Snake River. A riparian maintenance plan should be developed by an interdisciplinary team to preserve the diversity and value of this ecosystem.

Summary of Findings and Service Position:

Construction of levees along the Snake River near Jackson Hole, Wyoming, and the resultant concentration of water flows has caused extensive erosion, resulting in loss of aquatic and terrestrial wildlife habitat and significantly changing the character of the Snake River ecosystem (U.S. Fish and Wildlife Service 1990). The proposed project, if successful, will provide

environmental and wildlife habitat restoration of riverine, wetland and riparian habitats within four selected study areas on the Snake River.

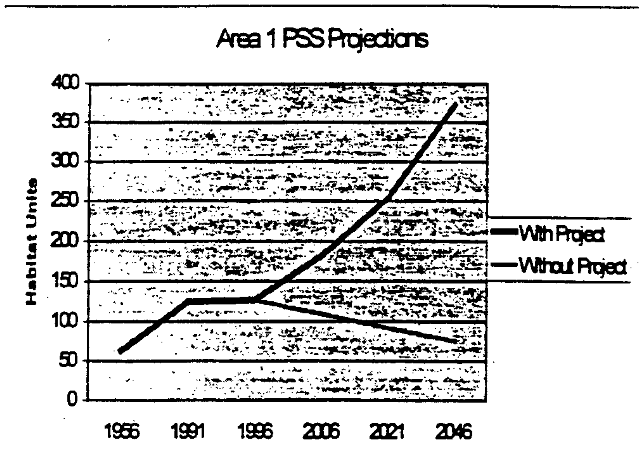
This project will benefit many species dependent on riparian habitat and facilitate restoration of the Snake River ecosystem within the four study areas. Specific examples include cottonwood regeneration for future bald eagle nesting and roosting sites, resting pools and habitat stability for the Snake River cutthroat trout, and restored habitat diversity for numerous passerines and mammals, including big game species. Impacts from construction and access will be minimal and will be offset by the anticipated benefits.

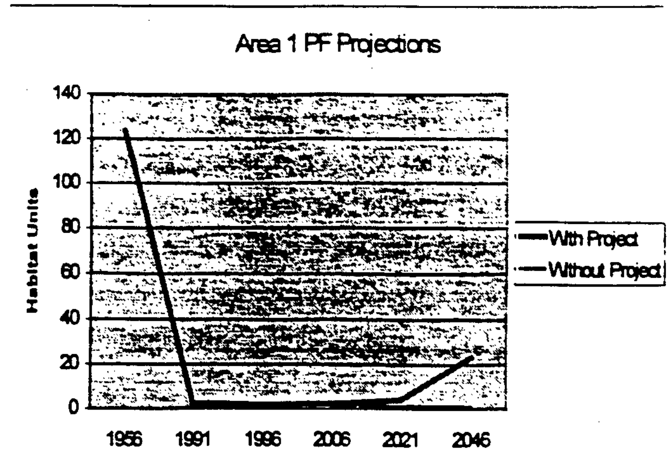
This project will result in an improvement of the riparian community impacted from extensive levee construction. Although the project is too limited in extent to fully offset past impacts of levee construction and maintenance, it is a very positive step toward restoring fish and wildlife habitat in this river system. The demonstration project proposed by the Teton County Natural Resources District is to determine if the proposed restoration techniques can accomplish large scale restoration efforts, and to stabilize islands, banks and channels in the limited demonstration area. The U.S. Fish and Wildlife Service supports this project.

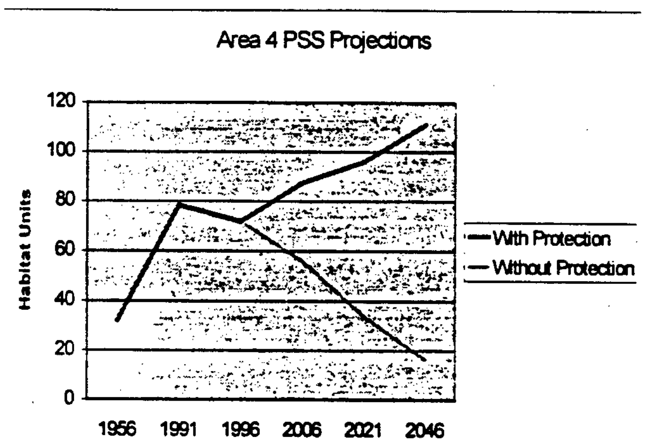
APPENDIX C

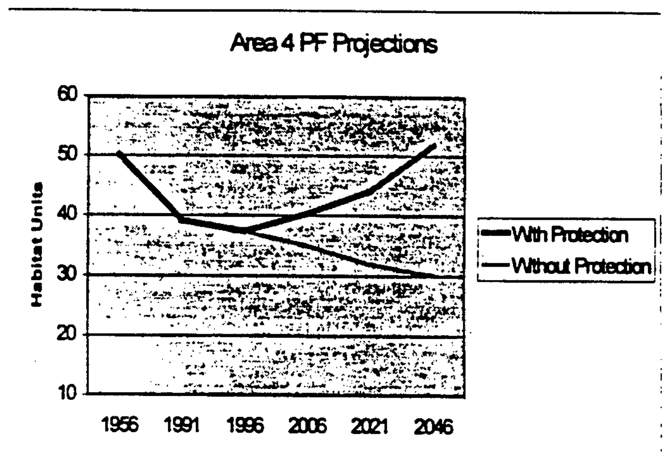
AQUATIC AND TERRESTRIAL BENEFITS WITH AND WITHOUT PROJECT BY AREA

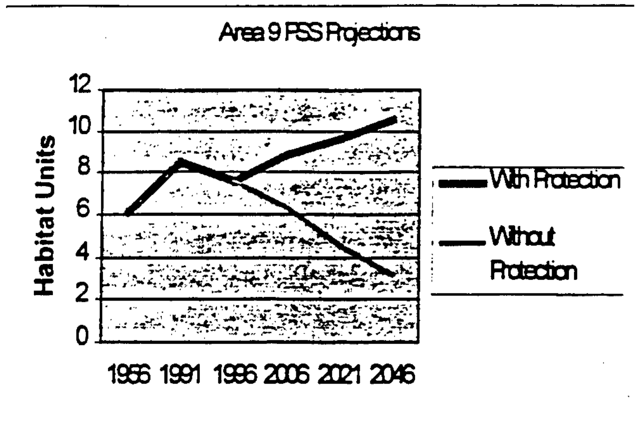
Site Specific Habitat Development Projections.







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Habitat Units
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10
8
6
4
2
0
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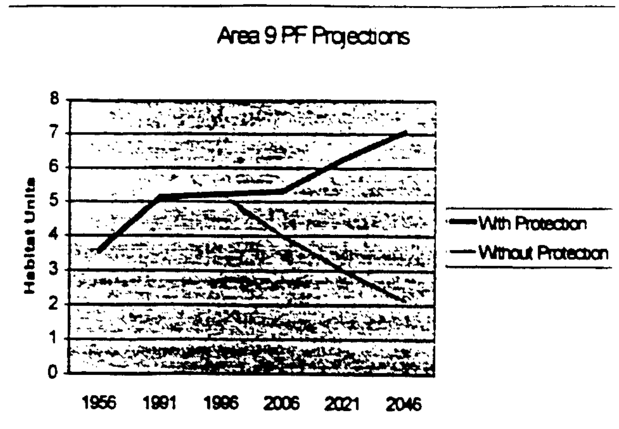
With Protection
Without Protection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Habitat Units
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2
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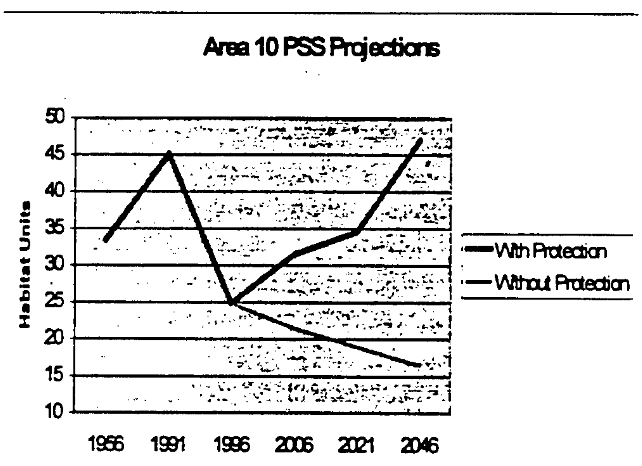
With Protection
Without Protection


Area 10 PSS Projections
Habitat Units
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30
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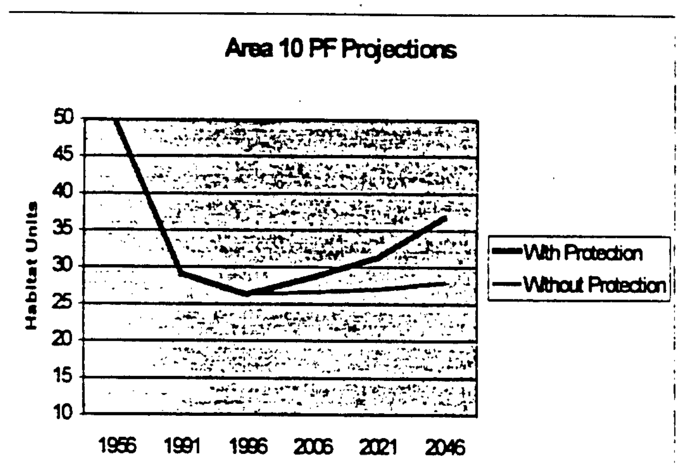
Without Protection


Area 10 PF Projections
Habitat Units
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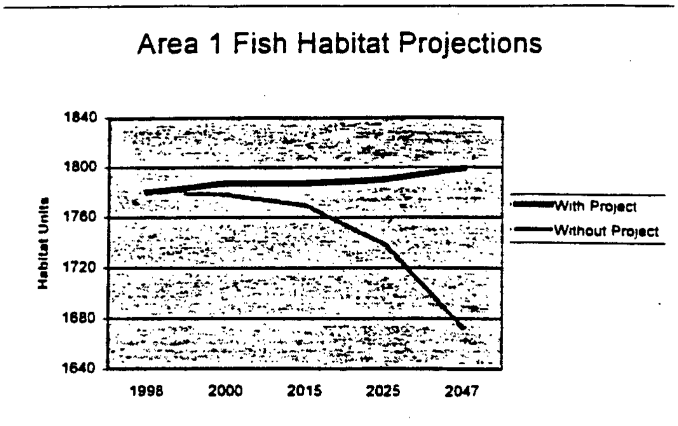
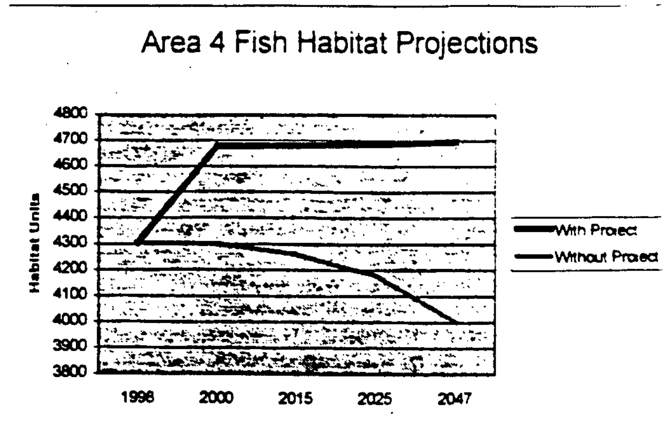
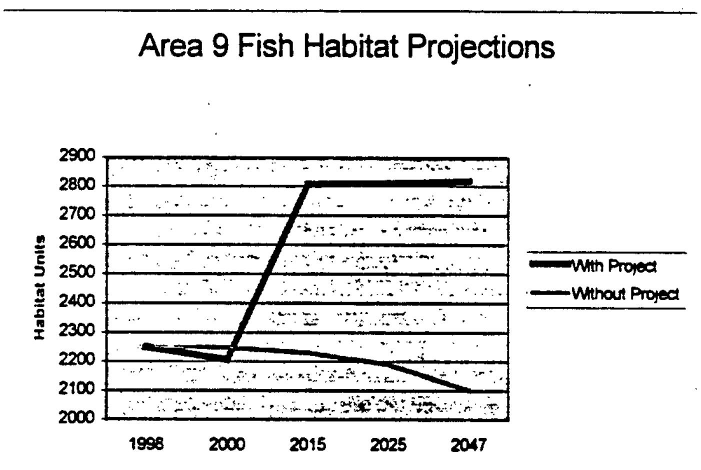
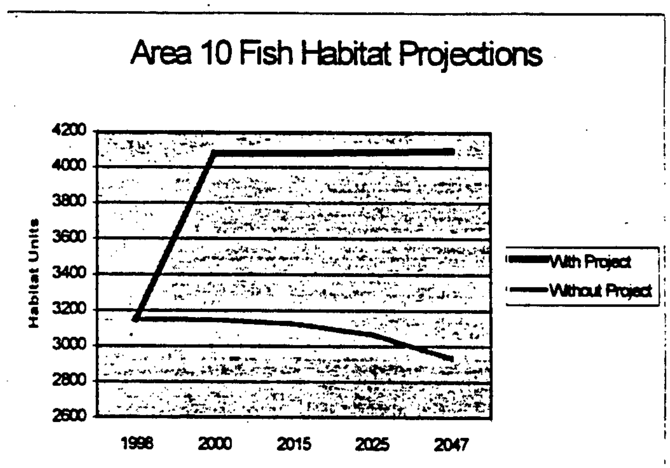
1956 1991 1996 2006 2021 2046
With Protection
Without Protection

Site Specific Fish Resting Habitat Development Projections.









APPENDIX D

CULTURAL RESOURCE CONCURRENCE LETTER FROM SHPO

DIVISION DIRECTOR
Karyl Denison Robb, Ph. D.

WYOMING

DIVISION OF CULTURAL RESOURCES

State Historic Preservation Office
6101 Yellowstone Road
Cheyenne, WY 82002

(307) 777-7697
FAX (307) 777-6421

COPY

February 11, 1997

Mr. Carl J. Christianson
Chief, Environmental Resources Branch
Department of the Army
Walla Walla District, Corps of Engineers
201 North Third Avenue
Walla Walla, WA 99362-1876

RE: Jackson Hole Environmental/Habitat Restoration Project Along the Snake River; SHPO #1289RLB055

Dear Mr. Christianson:

Karen Kempton of our staff has received information concerning the aforementioned project. Thank you for allowing us the opportunity to comment.

We have reviewed the project report and find the documentation meets the Secretary of the Interior's Standards for Archaeology and Historic Preservation (48 FR 44716-42). No sites meeting the criteria of eligibility for the National Register of Historic Places will be affected by the project as planned. We recommend the Corps of Engineers (COE) allow the project to proceed in accordance with state and federal laws subject to the following stipulation: if any cultural materials are discovered during construction, work in the area should halt immediately and the COE staff and SHPO staff must be contacted. Work in the area may not resume until the materials have been evaluated and adequate measures for their protection have been taken.

This letter should be retained in your files as documentation of our determination of "no effect" for this project.

We would like to remind you that we have not yet received follow up information regarding the Jackson Hole Flood Protection Levee Access Improvements project for which we received a FONSI in late November 1996. In a letter dated January 17, 1995 we agreed with your recommendations calling for a Class III survey of the proposed project areas. We look forward to further consultation regarding that project.

Please refer to SHPO project control number #1289RLB055 on any future correspondence dealing with this project. If you have any questions, contact Karen Kempton at 307-777-6292 or Judy Wolf, Deputy SHPO, at 307-777-6311.

Sincerely,

Judy K. Wolf
for John T. Keck
State Historic Preservation Officer

JTK:KLK:jh

THE STATE OF WYOMING
Jim Geringer, Governor

DEPARTMENT OF COMMERCE
Gene Bryan, Director

APPENDIX E

CLEAN WATER ACT
SECTION 404(b)(1) EVALUATION

APPENDIX E

JACKSON HOLE, WYOMING, ENVIRONMENTAL
RESTORATION PROJECT
SECTION 404(b)(1) EVALUATION
(40 CFR 230 - dated December 24, 1980)

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TABLES

APPENDIX E

JACKSON HOLE, WYOMING, ENVIRONMENTAL RESTORATION PROJECT SECTION 404(b)(1) EVALUATION (40 CFR 230 - dated December 24, 1980)

1. PROJECT DESCRIPTION.

a. Location.

The proposed environmental restoration project would occur at four locations: Areas 1, 4, 9, and 10, near the towns of Wilson and Jackson in Teton County, Wyoming. Area 1 is located in Sections 13, 14, 23, and 24, Township 40 N., Range 117 W; Area 4 is located in Sections 2, 3, 10, and 11, Township 40 N., Range 117 W; Area 9 is located in Sections 13 and 24, Township 41 N., Range 117 W; and Area 10 is located in Sections 5, 6, and 7, Township 41 N., Range 117 W. (Refer to plate 1.)

b. General Description.

The U.S. Army Corps of Engineers (Corps) plans to restore wetland and riparian habitats in the Snake River in response to environmental resource impacts resulting from levees constructed along the Snake River at Jackson, Wyoming. Over time, the levees have significantly changed the physical character of the river system and contributed to the loss of environmental resources. The presence of the levees has reduced the size of the actual floodplain resulting in a degraded condition of the area between the levees. Most notable effects include changes in channel configuration, which have eliminated natural braiding and reduced the number and size of islands. Associated with this change is the constriction of the floodplain and concentration of flow between the levees, resulting in higher velocities through the area. The high-velocity flows erode the river bottom gravels, islands, and vegetation along the banks. Aquatic habitat effects include loss of spawning area for the Snake River fine-spotted cutthroat trout, difficult passage to spring creeks for fish spawning, and loss of low-energy resting habitat for fish. Wildlife habitat effects include loss of shrub-willow cottonwood riparian areas used by moose, elk, mule deer, furbearers, numerous small mammals, and various other wildlife species.

The proposed project would employ a variety of tools aimed at protecting and improving habitat in and along the designated stretch of the Snake River. The project would involve construction of channel stabilization pools, secondary channels, off-channel pools, eco fences (both rock and piling), spur dikes (bank barbs and kickers), rock grade control structures, and anchored root wad logs.

Cumulatively, the tools would involve temporary and permanent discharges of dredged material and permanent discharges of riprap.

Gravel removal would be used to increase channel capacity. and construct off-channel pools, secondary channels leading to and from the off-channel pools, and channel stabilization pools. These tools are intended to maintain channel stability, improve sediment transport, and diversify fish habitat. Gravel removal to increase channel capacity would compensate for discharges of dredged and fill material, thereby, ensuring the base flood flow capacity is maintained.

Eco fences would be employed to protect existing islands from erosion and to rebuild islands through deposition. Spur dikes would be placed to slow bank erosion and create in-water fish habitat. Rock grade control structures would be used to prevent erosion and protect existing riparian and aquatic habitat. Anchored root wad logs would also be used to protect existing islands and promote deposition in an attempt to restore eroded islands.

The shifting nature of the braided river is expected to have some effect upon the structures. The extent of effects would vary between structures and from site to site, depending upon river conditions. Some structures would likely require maintenance to ensure they continue to function as designed. The frequency of maintenance would be dictated by the extent of river effects upon the structures. Completed structures would be monitored to identify effects of river flows and the need for maintenance. Monitoring procedures for structure integrity and function and aquatic and terrestrial habitat changes would be contained in a monitoring plan that would be developed by the Corps prior to implementation of the project. Maintenance would likely be necessary for channel stabilization pools, secondary channels, off-channel pools, eco fences, and spur dikes. Typical maintenance activities might include: removal of gravel from off-channel pools and the upper end of secondary channels leading to the off-channel pools, removal of gravel from channel stabilization pools, measures to reset piles and reattach cables on piling eco fences, and the addition of large rock to rebuild eroded spur dikes. The quantity of materials necessary that perform maintenance to the various structures would depend upon the extent to which maintenance may be needed. Any discharges necessary to conduct maintenance would be consistent with the materials, methods, and disposal sites identified in the Jackson Hole, Wyoming, Environmental Restoration Project, Environmental Assessment, and this 404(b)(1) evaluation.

c. <u>Purpose</u>.

The purpose of the project is to restore fish and wildlife habitat that was lost as a result of construction, operation, and maintenance of the Jackson Hole Flood Control Project, including levees constructed by non-Federal interests. The project is intended to preserve and enhance remaining terrestrial and aquatic habitat and

replace portions of habitat lost due to the effects of the levees upon the river system.

d. <u>Description of Method for Dredging and Placement of Materials</u>.

(1) <u>General Description</u>.

Gravel would be removed to compensate for reduction in channel capacity caused by discharges of fill material and deposition of sediments around the completed structures. Gravel removal would also be necessary in the construction of channel stabilization pools, off-channel pools, secondary channels, eco fences, rock grade control, and spur dikes. Riprap fill material would be used to construct eco fences, spur dikes, and rock grade control.

All work would be accomplished in a manner that would comply with Quality Standards for Wyoming Surface Waters and all terms and conditions detailed in the Federal Water Pollution Control Act §401 Certification from Wyoming Department of Environmental Quality, if issued. The Snake River is classified as Class 1 upstream of the Wyoming Highway 22 bridge. Areas 9 and 10 fall within this reach. Areas 1 and 4 are downstream of the bridge and fall within Class 2 surface waters. Classes 1 and 2 water carries basically the same water quality standards for protection of aquatic life. The standards most pertinent to this project require that turbidity increases downstream from the activity shall not exceed 10 Nephelometric Turbidity Units (NTU's) above background (upstream) levels. Currently, the standards do not allow for short-term increases in turbidity above this level. However, proposed changes to the regulations include allowance for short-term increases of turbidity made on a case-by-case basis. There is also a requirement for zone of passage, or a continuous water route that joins segments of a surface water body above and below a mixing zone. Such routes would be comprised of continuous flow with less than 10 NTU above background around the work site.

(a) <u>Gravel Removal</u>.

Gravel removal includes excavations to increase channel capacity and excavations to construct channel stabilization pools, off-channel pools and secondary channels. Gravel removal would be conducted either in the dry, above the level of the existing water surface flow, or within areas separated from surface flows by a temporary diversion or berm. Water diversion materials would be scooped from adjacent cobble, gravel, and sand deposits above the existing water surface flow and discharged to construct temporary diversion berms where needed to de-water excavation sites. Water diversion berms would specifically be used to alternately de-water channels at Area 9 north of the bridge to allow the channel capacity excavations to occur in non-flowing waters. Use of diversions at other locations would be dictated by site conditions that exist at excavation sites at the

time of construction. Following completion of work within the de-watered areas, the berm material would be scooped and transported to a permitted gravel processing facility for disposal.

Gravel removal would be accomplished using a track-mounted excavator, rubber-tired backhoe, or other similar equipment, along with trucks to transport the material to disposal and stockpile sites. The 4-inch plus cobble would be screened from the removed gravel and permanently discharged as dredged material below the ordinary high water mark (OHWM) to rearmor the bottom of the channel capacity, channel stabilization pool, off-channel pool, and secondary channel gravel removal sites. The excavated cobble, gravel, and sand may be temporarily stockpiled in the dry below the OHWM in preparation for screening. The 4-inch plus screened cobble material may also be temporarily stockpiled below the OHWM in preparation for rearmoring the gravel removal sites. Temporary stockpile sites would be gravel deposit areas free of vegetation. Cobble, gravel, and sand that would not be screened, as well as any excess 4-inch plus cobble, would be transported by truck to a permitted gravel processing facility for disposal prior to anticipated high flows. The channel bottom of channel capacity excavations, channel stabilization pools, and secondary channels would be armored with the 4-inch plus cobble. During low-flow periods, armor material would be placed in rows spaced 10 feet apart on center, aligning perpendicular to the channel centerline. The rows would have a cross-sectional area equivalent to 10 square feet. This would provide a volume of armor equivalent to a 1-foot-thick layer of armor on the channel bottom. The bottom of off-channel pools would be armored at the upper ends of the channels with a layer of 4-inch plus cobble, approximately 12 inches thick.

(b) Secondary Channels.

Secondary channels would provide water to and from off-channel pools. Material would be scooped with an excavator and side-cast and spread onto adjacent, unvegetated gravel deposits as a permanent discharge of dredged material. The dredged material would be evenly spread over the gravel bar using the excavator. However, if dump truck access routes are available, which would have minimal disturbance upon vegetation, the material would be scooped and transported to a permitted gravel processing facility for disposal. Disposal on adjacent gravel deposits would be below the OHWM, in the dry and above the low flow of the river.

(c) Off-channel pools.

An excavator would scoop gravel from the pool site, side-cast and spread the material onto adjacent, unvegetated gravel deposits as a permanent discharge of dredged material. The dredged material would be evenly spread over the gravel bar. However, if dump truck access routes are available, which would

have minimal disturbance upon vegetation, the material would be scooped and transported to a permitted gravel processing facility for disposal. Disposal on adjacent gravel deposits would be below the OHWM, in the dry and above the low flow of the river.

(d) Eco Fences.

Two different types of fences may be used: piling eco fences and rock eco fences. An excavator may remove and reposition cobbles and gravel to prepare the site for driving the piles. No discharges of fill material would occur in connection with the piling eco fences. Rock eco fences, constructed of riprap, would require repositioning of cobble, gravel, and sand to embed the structure into the channel bottom. Riprap would be trucked to the site and dumped directly into the excavated site.

(e) Bank Barbs.

Bank barbs would be built of riprap and would extend up to 30 feet into the river from the adjoining levee. Gravel and cobble excavated to embed the structure would be transported to a permitted gravel processing facility for disposal. Equipment used to excavate for the barbs and to place riprap would sit atop the levee and would maneuver onto the top of the barb when necessary.

(f) Kickers.

Kickers would be composed of riprap armor extending up to 60 feet from the adjoining levee. Gravel and cobble excavated to embed the kickers would be used as the random core fill material. Excavated material would be temporarily stockpiled out of the channel on the adjacent levee. The structure would be tied into the adjoining levee. Equipment used to excavate for the kickers and to place riprap would sit atop the levee and would maneuver onto the top of the kicker, when necessary.

(g) Rock Grade Control.

Existing cobble, gravel, and sand would be removed to a standard uniform depth of 3 feet below the ground surface by an excavator. The material would be scooped and transported off-site to a gravel processing facility for disposal. The area would then be graded and filled with riprap to match existing topography. Riprap would be transported to the site by truck, dumped, and spread using an excavator to achieve uniform depth. Material would be placed below the OHWM, in the dry, and above the level of existing water flows.

(h) Anchored Root Wad Logs.

Root wad logs would be obtained from along the river channel within the four project areas. Equipment would be used to either transport or drag the logs to the installation site. Root wad logs that must be transported across low-flow channels would be dragged across using a cable winch. Minor repositioning of cobble, gravel, and sand may be required to partially embed root wad logs into the channel bottom.

e. Description of the Proposed Discharge Site.

(1) Location.

The locations of project Areas 1, 4, 9, and 10 are identified in paragraph 1.a. above and on plate 1.

(a) Gravel Removal.

Discharges of dredged 4-inch plus cobble would occur upon the disturbed bottom surface of the channel capacity and channel stabilization pool excavation sites. Any excavated cobble, gravel, and sand temporarily stockpiled in preparation for screening, and temporarily stockpiled screened cobble, would be placed above the existing water level, in the dry, upon adjacent gravel deposits. Excavated material that would not be screened would be transported from the channel and disposed at a permitted gravel processing facility in uplands.

(b) Secondary Channels.

Dredged cobble, gravel, and sand would either be permanently side-cast on adjacent, unvegetated gravel deposits or transported to a permitted gravel processing facility in uplands for disposal.

(c) Off-channel pools.

Dredged cobble, gravel, and sand would either be permanently side-cast on adjacent, unvegetated gravel deposits or transported to a permitted gravel processing facility in uplands for disposal.

(d) Eco Fences.

Discharges of dredged material would occur when the cobble, gravel, and sand is smoothed, leveled, or repositioned to facilitate placement of both rock and piling eco fences. Gravel would be moved only as necessary to partially embed the eco fences into the river bottom. The minor amount of removed

material would be side-cast and spread around and adjacent to the structures as a permanent discharge of dredged material.

(e) Bank Barbs.

Dredged cobble, gravel, and sand may be temporarily stockpiled on the adjacent levee, above the OHWM. The dredged material would be transported to a permitted gravel processing facility for upland disposal. Riprap fill material would be placed below the OHWM on the bottom of the disturbed excavation site.

(f) Kickers.

Dredged cobble, gravel, and sand would be temporarily stockpiled on the adjacent levee, above the OHWM. Permanent discharges of the dredged cobble, gravel, and sand would occur below the OHWM as core material for each kicker. Riprap fill material would be placed below the OHWM on the bottom of the disturbed excavation site.

(g) Rock Grade Control.

Dredged cobble, gravel, and sand would be transported to a permitted gravel processing facility upland for disposal. Riprap fill material would be placed below the OHWM on the bottom of the disturbed excavation site. Rock grade control to be constructed in Area 9 only, based on current river conditions.

(h) Anchored Root Wad Logs.

Permanent discharges of dredged material would occur when the cobble, gravel, and sand is smoothed, leveled, or repositioned to facilitate anchoring of root wad logs. Gravel would be repositioned only as necessary to partially embed the root wad logs into the gravel deposits.

(2) Type of Site.

Areas 1, 4, 9, and 10 all consist of a cobble, gravel, and sand substrate. All work affecting the substrate would occur in the dry with the exception of the discharge of dredged material to construct temporary water diversions, excavations, and discharges of dredged and fill material to construct spur dikes, and discharge of dredged 4-inch plus cobble to armor certain excavation sites. Spur dike and water diversion construction would occur in the flowing portion of the low-flow stream. Excavation sites to be armored with 4-inch plus cobble would likely contain water that would have infiltrated through the cobble, gravel, and sand substrate. The water would be separated from surface flows of the low-flow stream by construction of a temporary water diversion.

(3) Type of Habitat.

The Snake River has two separate classifications as a surface water of the State of Wyoming. The portion of the river upstream of the Wyoming Highway 22 bridge (which includes Areas 9 and 10) is classified as a Class 1 water. That portion of the river downstream of the bridge, which includes Areas 1 and 4, is Class 2 water.

Water quality in the upper Snake River and its tributaries is generally high most of the year. Data reported in the 1996 and 1997, U.S. Geological Service (USGS) Water Resources Data, Idaho, Volume 1, show that at the Snake River at Moose, Wyoming, gage site maximum water temperatures usually remain below 60.8 °F; pH generally ranges in value from 7.8 to 8.4; dissolved oxygen saturation is always near 100 percent; specific conductance ranges from 100 to 200 micro Siemens per centimeter (µS/cm); nitrate nitrogen is generally below 0.12 parts per million (ppm) as nitrogen (N); ammonia nitrogen below 0.08 ppm as N; orthophosphorous is generally below 0.020 ppm as phosphorus (P); and total phosphorous concentrations are usually less than 0.20 ppm as P. Measured suspended sediment concentrations are less than 30 mg/l during low-flow periods. Turbidity is generally the greatest water quality problem and increases with high runoff. Sources of turbidity at high flows are generally erosion from surface runoff and tributaries. Jackson Lake influences the channel regime in the upper part of the river by removing all but the finest suspended sediment from the water. All of the bedload in the lower river is derived from tributary streams and from erosion of the channel and channel banks downstream of Jackson Lake.

(4) Timing and Duration of Discharge.

Construction of the project would begin in August 2001 and continue into 2004. Construction would occur at only one of the four sites each year. Discharges of dredged and fill material would occur during low river flows. Low-flow periods generally occur from October 15 until March 15.

f. General Description of Dredged or Fill Material.

(1) General Characteristic of Material.

(a) Dredged Material.

Materials to be excavated at Areas 1, 4, and 10 are generally composed of a cobble layer on the surface, underlain by poorly graded gravel with sand. Area 9 consists of the same cobble layer; however, it is underlain by a well-graded gravel with sand. The cobble layer at all four areas is approximately 12 inches thick with a maximum particle size of 12 inches.

(b) Discharges of Dredged Material.

Both temporary and permanent discharges of dredged cobble, gravel, and sand would occur below the OHWM. In addition, permanent discharges of 4-inch plus cobble dry screened from dredged cobble, gravel, and sand would also occur below the OHWM.

(c) Fill Material.

Permanent discharges of fill material would consist of riprap and root wad logs. Riprap would be clean angular rock, free of fines, with an average diameter of 2 feet. Root wad logs would consist of irregular shaped tree trunks with the root wad attached. A minor amount of soil may still be attached to the root wad.

(d) Discharges of Fill Material.

Riprap fill would be used to construct rock eco fences, spur dikes, and rock grade control structures.

(2) Quantity of Material and Size of Excavation and Discharge Areas.

Multiple numbers of structures and varying amounts of excavation and discharges would occur within each of the four project areas. The quantities identified below represent approximate maximum quantities. Actual quantities could exceed the estimates, but are most likely to be less than the maximum identified.

(a) Gravel Removal to Construct Channel Stabilization Pools and Maintain Channel Capacity.

Gravel would be removed to construct channel stabilization pools and to maintain channel capacity within the 100-year event base flood capacity. The 4-inch plus cobble would be screened from the removed gravel and permanently discharged as dredged material below the OHWM to rearmor the bottom of the channel capacity and channel stabilization pool gravel removal sites.

The excavated cobble, gravel, and sand may be temporarily stockpiled below the OHWM in preparation for screening. The 4-inch plus cobble screened material may also be temporarily stockpiled below the OHWM in preparation for rearmoring the bottom of the channel stabilization pools and channel capacity excavation sites. Temporary stockpile sites would be gravel deposit areas free of vegetation and above the elevation of the flowing water. Cobble, gravel, and sand not screened would be transported by truck to a permitted gravel processing facility for disposal. Refer to tables E-1 and E-2 for excavation quantities and size of areas.

Table E-1. Channel Capacity Excavation and Channel Stabilization Pools. Gravel Removal Quantities and Size of Areas.

	Area 1	Area 4	Area 9	Area 10
Channel Capacity Excavation	37,000 cy[1/]	128,800 cy	130,000 cy	9,630 cy
	16 acres	17.4 acres	31.0 acres	1.5 acres
Channel stabilization pool Excavation	97,000 cy	429,600 cy	0 cy	272,000 cy
	19 acres	33.1 acres	0 acres	19 acres

[1/] Cubic yards.

Table E-2. The 4-Inch Plus Cobble to Armor Channel Stabilization Pools and Channel Capacity Excavation Sites. Discharge Quantities and Size of Areas.

	Area 1	Area 4	Area 9	Area 10
Channel Capacity Excavation	7,350 cy	25,760 cy	26,000 cy	1,926 cy
	16 acres	17.4 acres	31.0 acres	1.5 acres
Channel stabilization pool	19,400 cy	85,920 cy	0 cy	54,400 cy
	19 acres	33.1 acres	0 acres	19 acres

(b) Secondary Channels.

Cobble, gravel, and sand would be excavated to enhance or construct secondary channels. This material would be side-cast and spread onto adjacent, unvegetated gravel deposits as a permanent discharge of dredged material. However, if dump truck access routes are available that would have minimal disturbance upon vegetation, the material would be scooped and transported to a permitted gravel processing facility for disposal. Refer to tables E-3 and E-4 for quantities and size of area.

Table E-3. Secondary Channels. Excavation Quantities and Size of Areas.

	Area 1	Area 4	Area 9	Area 10
Excavation to Construct Secondary Channels	700 cy	1,120 cy	500 cy	0 cy
	0.14 acre	0.23 acre	0.1 acre	0 acres

Table E-4. Secondary Channels. Discharge Quantities and Size of Areas of 4-Inch Plus Cobble to Armor Secondary Channels.

	Area 1	Area 4	Area 9	Area 10
Discharge of 4-inch Plus Cobble	140 cy	0 cy	100 cy	0 cy
	0.14 acre	0 acres	0.1 acre	0 acres

(c) Off-Channel Pools.

Cobble, gravel, and sand would be excavated to enhance or construct off-channel pools. This dredged material would be side-cast and spread onto adjacent, unvegetated gravel deposits as a permanent discharge of dredged material. However, if dump truck access routes are available that would have minimal disturbance upon vegetation, the material would be scooped and transported to a permitted gravel processing facility for disposal. Refer to tables E-5 and E-6 for quantities and size of areas.

Table E-5. Off-Channel Pools. Excavation Quantities and Size of Areas.

	Area 1	Area 4	Area 9	Area 10
Excavation to Construct Pools	48,000 cy	32,000 cy	0 cy	12,000 cy
	9.9 acres	5 acres	0 acres	2.5 acres

Table E-6. Off-Channel Pools. Discharge Quantities and Size of Areas of 4-inch Plus Cobble to Armor Off-Channel Pools.

	Area 1	Area 4	Area 9	Area 10
Discharge of 4-Inch Plus Cobble	9,600 cy	6,400 cy	0 cy	2,400 cy
	9.9 acres	5 acres	0 acres	2.5 acres

(d) Eco Fences.

The quantity of gravel removal necessary to embed eco fences into the gravel deposits would depend upon the site selected for placement of the structure. Gravel would be moved only as necessary to embed eco fences into the river bottom or create an area for driving piles. The removed material would be temporarily stockpiled adjacent to the excavation site and subsequently used to permanently embed the completed structures. No discharges of fill material are necessary for construction of pile supported eco fences. Refer to table E-7 for quantities and size of areas.

Table E-7. Eco Fences. Excavation and Discharge Quantities and Size of Areas. Numbers Shown under Each Type of Eco Fence Represent the Combined Quantity and Combined Size of All Structures in that Category.

	Area 1		Area 4		Area 9		Area 10	
Type of Eco fence	Piling Fence	Rock Fence	Piling Fence	Rock Fence	Piling Fence	Rock Fence	Piling Fence	Rock Fence
Excavation to Embed Structure	1,700 cy	5,450 cy	28,330 cy	9,241 cy	250 cy	670 cy	1,800 cy	5,860 cy
	3,660 ft[1/]	3,660 ft	6,210 ft	6,210 ft	430 ft	430 ft	3,930 ft	3,930 ft
Discharge of Dredged/ Excavated material	1,700 cy	5,450 cy	28,330 cy	9,241 cy	250 cy	670 cy	1,800 cy	5,860 cy
	3,660 ft	3,660 ft	6,210 ft	6,210 ft	430 ft	430 ft	3,930 ft	3,930 ft
Discharge of riprap	0 cy	7,100 cy	0 cy	12,065 cy	0 cy	850 cy	0 cy	7,650 cy
	0 ft	3,660 ft	0 ft	6,210 ft	0 ft	430 ft	0 ft	3,930 ft

[1/] Feet.

(e) <u>Bank Barbs</u>.

Cobble, gravel, and sand would be excavated to embed bank barbs into the riverbed. The material would be temporarily stockpiled on the adjacent levee, above the OHWM. This material would be transported to a permitted gravel processing facility for upland disposal. Riprap fill material would be permanently discharged below the OHWM to construct bank barbs. Refer to table E-8 for quantities and size of areas.

Table E-8. Bank Barbs. Excavation and Discharge Quantities and Size of Areas.

	Area 1	Area 4	Area 9	Area 10
Excavation to Embed Bank Barbs	0 cy	100 cy (combined total for 5 structures)	140 cy (combined total for 7 structures)	240 cy (combined total for 12 structures)
	0 acres	0.1 acre	0.1 acre	0.3 acre
Discharge of Riprap	0 cy	200 cy (combined total for 5 structures)	280 cy (combined total for 7 structures)	480 cy (combined total for 12 structures)
	0 acres	0.1 acre	0.1 acre	0.3 acre

(f) <u>Kickers</u>.

Cobble, gravel, and sand would be removed to embed kickers into the river bottom. The material would be temporarily stockpiled on the adjacent levee, above the OHWM. This dredged material would be permanently discharged back into the river as core material for kickers. Riprap fill material would be

permanently discharged below the OHWM to construct kickers. Refer to table E-9 for quantities and size of areas.

Table E-9. Kickers. Excavation and Discharge Quantities and Size of Areas.

	Area 1	Area 4	Area 9	Area 10
Excavation to Embed Kickers	0 cy	1,000 cy (combined total for 5 structures)	1,600 cy (combined total for 8 structures)	2,600 cy (combined total for 13 structures)
	0 acres	0.4 acre	0.6 acre	1 acre
Dredged Material Discharge	0 cy	1,000 cy (combined total for 5 structures)	1,600 cy (combined total for 8 structures)	2,600 cy (combined total for 13 structures)
	0 acres	0.4 acre	0.6 acre	1 acre
Discharge of Riprap	0 cy	750 cy (combined total for 5 structures)	1,200 cy (combined total for 8 structures)	1,950 cy (combined total for 13 structures)
	0 acres	0.4 acre	0.6 acre	1 acre

(g) Rock Grade Control.

Rock grade control would be constructed in Area 9 only, based on current river conditions. Prior to the start of construction, river conditions may create new areas that warrant rock grade control. Approximately 3,500 cy of cobble, gravel and sand would be excavated to embed riprap into the river bottom to construct rock grade control at Area 9. This material would be scooped and transported to a permitted gravel processing facility in uplands for disposal. Approximately 3,500 cy of riprap fill material would be permanently discharged below the OHWM. Rock grade control would encompass approximately 0.7 acres at Area 9.

(h) Anchored Root Wad Logs.

The quantity of gravel removal necessary to position and anchor root wad logs in the gravel bed would depend upon the site selected for placement of the structure. The quantity is expected to be minimal. Gravel would be moved only as necessary to position and partially embed the root wad logs. No discharges of fill material are necessary for placement of anchored root wad logs.

(3) Source of Material.

The Snake River is the source of cobble, gravel and sand that would make up the permanent and temporary discharges of dredged material. Riprap fill would be obtained from an upland site to be selected by the construction contractor. Root wad logs would be obtained from the existing assortment of downed woody debris located within the four project areas. If needed, additional root wad logs may be obtained commercially from Walton Quarry, located near Area 9 or Jackson Lake.

2. FACTUAL DETERMINATIONS.

a. Physical Substrate Determinations.

(1) Substrate Elevation and Slope.

In 1996, the active channel substrate elevation in Area 1 is approximately 6,000 feet National Geodetic Vertical Datum (NGVD) of 1929 and channel slope was 14.4 feet per mile. Area 4 has an approximate elevation of 6,075 feet NGVD and slope of 8.4 feet per mile. The Area 9 approximate elevation is 6,160 feet NGVD with a slope of 18.2 feet per mile. Area 10 elevation is approximately 6,240 feet NGVD and slope is about 19.8 feet per mile.

(2) Substrate Particle Size.

Surface materials vary widely from sandy silt to large 6- to 10-inch cobble with the largest materials generally located in the active channel bottoms, finer materials located in protected areas downstream of vegetation or debris, and areas distant from the main channel.

Underneath the surface layer, which may range from 6 to 12 inches, the material consists of a much more uniformly distributed mix of sand through cobble sizes. The 4-inch plus cobble make up about 5 percent of the subsurface materials in Areas 1 and 4 and about 15 percent to 18 percent of the subsurface materials in Areas 9 and 10 (based on samples collected at each site).

(3) Dredged/Fill Material Movement.

The project sites are in a reach of the Snake River that is highly unstable. Though the measures proposed are meant to improve stability, the inherent nature of high velocity-streams would result in some displacement of materials placed during construction. Cobbles placed to provide streambed armor in channel capacity excavation areas would be redistributed over the bottom surface by high flows. Materials that may be side-cast onto dry gravel bars during

construction of channel stabilization pools, off-channel pools, and secondary channels would likely move when river flows are high enough to influences those areas. The rock grade control is intended not to move but to prevent erosion or down-cutting of the channel. However, the riprap material placed there may move until it settles. Anchored root wad logs, rock eco fences, and piling eco fences are intended to be relatively permanent fixtures. As with the other project techniques, they would be monitored for movement. Bank barbs and kickers are expected to experience some erosion by impingement by high-velocity flows. Due to the large angular nature of the riprap material, which would be used to construct them, it is not likely that the fill material would move very far.

(4) Physical Effects on Benthos.

Excavations for channel capacity, off-channel pools, channel stabilization pools, secondary channels, rock eco fences, rock grade control, and spur dike kickers could affect the benthos, by removing and/or destroying them. Benthos could also be affected by discharges of dredged material placed back into the channel capacity, side pool, and channel stabilization pool excavation sites (although these areas will have just been disturbed). Discharges of cobble, gravel and sand resulting from off-channel pool and secondary channel excavations may also affect benthos (although this material may be spread on the adjacent gravel bars above the low flow of the channel, and discharges of riprap to construct spur dikes and eco fences). The benthos impact would be somewhat reduced due to the ability of some benthic invertebrates to migrate with the water. There would likely be a lot of invertebrate drift downstream to nonimpacted areas. Recolonization of disturbed areas is expected to occur soon after disturbance, whenever the first flows begin over those areas. In areas where measures would be taken to increase sedimentation rates (*e.g.*, downstream of eco fences along island shorelines) sedimentation rates are expected to be slow enough to allow escape of macro-invertebrates.

(5) Other Effects.

No other effects are anticipated.

(6) Actions Taken to Minimize Impacts.

A Corps biologist would be on-site to coordinate with the contractor. All in-water work would be conducted during low-water flows in the Snake River. Low water generally occurs from approximately October through April.

b. Chemical Description of Materials.

Due to the coarse nature of all dredge and fill materials, which would be handled during this project, no chemical analyses have been performed. A Tier 1

evaluation indicated no need for further assessment of contaminants in the substrate. However, low concentrations of dissolved atrazine (0.005 µg/l and less) were reported in water sampled in 1996 and 1997 by the USGS at the Snake River at Moose, Wyoming, Station (USGS Water-Data Report ID-96-1 and ID-97-1). There is no reason to believe that the sediments contain any chemicals in concentrations of concern. The fill material that would be brought in (riprap) would be free of chemical contaminants.

c. Water Salinity, Circulation, and Fluctuation Determinations.

(1) Water.

(a) Salinity.

No effect.

(b) Water Chemistry.

Slight decreases in dissolved oxygen may occur during in-water work periods, but the spatial extent would be small and duration would be short. Compliance with Wyoming Surface Water Quality Standards would result in only acceptable changes in water quality. No discharges of chemicals are proposed as part of this project.

(c) Clarity.

In-water work would result in increases in suspended sediments in the water column. A turbidity monitoring program would be implemented during any in-water construction activities. Restricting decreases in water clarity by limiting increases in turbidity to no more than 10 NTU's above background would ensure that visible plumes of water, with lessened clarity, do not extend far downstream and are short lived. When the river is returned to flow over an excavated area, there would be an initial increase in turbidity as the flow picks up the fine material from the surface. This should be of very short duration, perhaps a few hours.

(d) Color.

Changes in water color that result from discharges of dredged or fill material would be linked to changes in water clarity and would be short lived.

(e) Odor.

No effect.

(f) Taste.

There are no known municipal or private potable water supply intakes immediately downstream of the four project areas: thus taste is not a relevant factor.

(g) Dissolved Gas Levels.

The project is not expected to have a substantial effect on total dissolved concentrations. Small, short-lived dissolved oxygen reductions could result in very minor reductions in total dissolved gas pressures.

(h) Nutrients.

Disturbance of sediments during in-water excavations and dissolution during in-water disposal may increase water column concentrations of inorganic and organic nutrients. Rapid dilution would occur. Excavations and discharges in the dry would have no impact upon nutrients.

(i) Eutrophication.

Creation of low-velocity habitat may result in increased biological productivity in those areas. This would be a desirable effect of this project. No negative eutrophication effects are expected.

(j) Others.

As off-channel pools are constructed, the temperature of any standing water that becomes exposed would increase with exposure to warm air temperatures and daylight. However, because these areas should be devoid of susceptible macroorganisms due to lack of connection with flowing water and prior desiccation, there should be no effect. Water from these pools would mix with cooler water from supply channels before entering the river.

(2) Current Patterns and Circulation.

(a) Current Pattern and Flow.

The project is designed to provide marked beneficial effects by changing flow patterns, depths, and velocities without impeding flows. No negative impacts are expected.

(b) Velocity.

No negative impacts are expected. Localized velocity decreases are expected. Positive impacts may occur if structures slow velocities sufficiently to allow deposition of a layer of soil and subsequent establishment of vegetation.

(c) Stratification.

No effect.

(d) Hydrologic Regime.

The project would not effect the normal river flows through the sites.

(3) Normal Water Fluctuations.

Normal water level fluctuations are affected by levees located throughout this stretch of the Snake River. It is assumed that the current situation represents the normal fluctuations. Velocities are increased through this stretch because of the levees. Because channel capacity excavations would compensate for discharges and deposition, the project should have minimal effect upon normal water fluctuations. No water would be taken out or added to the river due to the project. However, modifications to the streambed would influence the frequency and duration of cobble bar inundation and saturation in affected areas.

(4) Actions that will be Taken to Minimize Impacts.

No further actions will be necessary.

d. Suspended Particulate/Turbidity Determinations.

(1) Expected changes in Suspended Particulates and Turbidity Levels in the Vicinity of the Site.

Test samples of the substrate in this reach of the river revealed less than 2 percent of the sediment to be very fine sand or smaller fines. Turbidity would be monitored and work modified to comply with water quality standards. Any effects that may result should be localized and dissipated rapidly; therefore, no significant reduction in primary productivity should occur.

(2) Effects (Degree and Duration) on Chemical and Physical Properties of the Water Column.

(a) Light Penetration.

Any increased turbidity occurring as a result of the proposed action would cause short-term reduction in light penetration. However, due to the anticipated limited effects upon the water column, effects on chemical and physical properties would be minor to negligible and short-lived. Also, any increases in turbidity above the standard would result in work stoppage until the turbidity returns to background levels. Due to the limited presence of fines in the river, little reduction in light penetration due to increased turbidity is expected.

(b) Dissolved Oxygen.

Slight reductions in dissolved oxygen concentrations may occur due to decomposition of resuspended organic matter but will be short lived.

(c) Toxic Metals and Organics.

The materials to be moved are relatively coarse in nature, therefore, should not contain contaminants. In addition, there are no known sources of contaminants in the area.

(d) Pathogens.

No effect.

(e) Aesthetics.

A minor turbidity plume would likely occur in the low-flow channel during in-water work. This plume is expected to be noticeable only during construction and should only extend a short distance downstream before dissipating. Effects of the increased turbidity are expected to be minor due to monitoring and modification of work in compliance with water quality standards. Turbidity increases lasting for a short time can be expected when flows first pass over areas that have been worked in the dry.

(f) Other.

No other effects.

(3) Effects on Biota.

(a) Primary Production. Photosynthesis.

Due to the limited presence of fines in the river, little reduction in light penetration due to increased turbidity is expected. Any effects that may result should be localized and dissipated rapidly, therefore, no significant reduction in primary productivity should occur. Increases in primary productivity may be expected in areas where low velocity habitat is enhanced (*e.g.*, off-channel pools, channel stabilization pools, and spur dikes).

(b) Suspension/Filter Feeders.

Prey and predators displaced from the work areas would find similar suitable habitat in the immediate vicinity of the disturbance. Invertebrate drift would increase from in-water work areas, enhancing downstream foraging during construction. Recolonization would occur rapidly. Zones of passage required around mixing zones to comply with water quality standards would be provided.

(c) Sight Feeders.

Sight feeding could be impacted within the turbidity plumes immediately downstream of in-water work. However, plumes of reduced water clarity would rapidly dissipate so impacts are expected to be minimal.

(4) Actions Taken to Minimize Impacts.

No further actions will be necessary.

e. Contaminant Determinations.

(1) Due to the coarse nature of the dredged and fill materials to be handled during this project, no direct contaminant analyses are required. There is no reason to believe that the substrate contains sufficient levels of chemical contaminants to cause concern.

f. Aquatic Ecosystem and Organism Determinations.

(1) Plankton Effect.

No effect.

(2) Benthos Effects.

Benthic communities in the construction area would be disturbed. buried, and/or destroyed. Upon completion of the project. adjacent benthic communities should colonize excavation sites and sites of discharged dredged and fill material.

(3) Nekton Effects.

Mobile aquatic organisms would likely move out of the immediate area of the proposed in-water work, but would return upon completion of the proposed actions.

(4) Aquatic Food Web Effects.

Disturbance and destruction of benthic communities at the proposed sites due to disturbances created by the project would cause local reduction in the available food supply to higher organisms resident to the sites. This would displace these resident populations to surrounding water until the food chain is reestablished. The benthic recolonization time period, and its impact upon the sites total food web should be negligible due to the limited scope of in-water work.

(5) Special Aquatic Site Effects.

(a) Sanctuaries and Refuges.

The National Elk Refuge is located approximately 3 miles east of the four project areas and Wyoming Game and Fish Department's South Park Habitat Unit is located east of Area 1. The project is not expected to have any effect upon sanctuaries and refuges.

(b) Wetlands.

Wetlands would not be adversely affected by excavation, discharges of dredged, or fill material, or equipment access. All work would occur in unvegetated cobble, gravel, and sand depositional areas located below the OHWM of the Snake River. The project would provide long-term potential for wetland establishment in areas of deposition downstream of anchored root wad logs and some eco fences. Silts deposited below these structures would provide suitable seedbed sites for natural vegetation regeneration. Off-channel pools would also provide opportunity for wetland establishment.

(c) Mud Flats.

Not applicable.

(d) Vegetated Shallows.

Not applicable.

(e) Riffle and Pool Complexes.

Kickers would create pools soon after they are installed. Anchored root wads have the potential to create additional pool areas depending on the channel migration pattern. Protection of existing vegetated islands may also provide more pool habitat over time by slowly releasing woody debris instead of many trees being washed away in one high-water event. Trees that fall into the river can be an important element of quality pools. The proposed project may cause an increase in the pool-to-riffle ratio of the project areas.

(6) Threatened and Endangered Species.

A Biological Assessment (BA) was prepared for the proposed action. In response to the BA, the U.S. Fish and Wildlife Service responded that the project may affect, but would not likely adversely affect, the bald eagle, peregrine falcon, whooping crane, grizzly bear, and gray wolf.

(7) Aquatic Life Forms.

The effects of the proposed action are expected to be minimal since the zone of turbidity around the project would be minor. Fish would be able to easily avoid the turbid areas.

(8) Land Based Life Forms.

Discharges are expected to have beneficial effects upon habitat for land based life forms by slowing the effects of erosion upon islands and associated vegetation. Protection of existing islands would promote maintenance of existing forage habitat for moose and other big game. Deposition of material behind anchored root wad logs and eco fences would provide potential for future forage growth for big game.

(9) Actions Taken to Minimize Impacts.

All work would be conducted during low-water flows in the Snake River. Low water generally occurs from October through April.

g. Proposed Disposal Site Determinations.

(1) Mixing Zone Determination.

The current Quality Standards for Wyoming Surface Waters define a mixing zone as "a limited area or volume of a surface water body within which an effluent becomes thoroughly mixed with the water body." In addition, the standards state that compliance with water quality standards shall be determined after allowing reasonable time for mixing. For the activities proposed in this project, the mixing zone would be assumed to extend downstream 300 feet or to a point immediately upstream of the next tributary or sub-channel confluence (where channel braids reconnect). Turbidity monitoring would be accomplished at this point unless directed otherwise by Wyoming Department of Environmental Quality (DEQ) in the 401 Certification, if issued.

(2) Determination of Compliance with Applicable Water Quality Standards and Regulations.

(a) Section 401 Certification.

Section 401 of the Clean Water Act requires that applicants requesting a Federal license or permit to conduct activities that may result in a discharge in waters of the United States, provide to the licensing or remitting agency, a certification from the State that any such discharge complies with the applicable water quality standards. This evaluation will be provided to the Wyoming DEQ for their consideration in evaluating the project for compliance under Section 401 of the Clean Water Act.

(3) Potential Effects on Human Use Characteristics.

(a) Municipal and Private Water supply.

No effect.

(b) Recreational and Commercial Fisheries.

Turbidity generated by in-water work would have only a minimal effect upon fishing activity within and downstream of the project area. Additional aquatic habitat would result almost immediately following construction of spur dikes. Long-term benefits are expected from establishment of additional habitat and improved habitat from construction of side pools, channel stabilization pools, eco fences, rock grade control, and anchored root wad logs. Additional and improved habitat would provide potential opportunity for dispersal of existing fish species and increased numbers of fish per habitat unit within the project area. Recreational fisheries are expected to experience benefits from the project.

(c) Water Related Recreation.

The discharges of dredged and fill material are expected to have beneficial, long-term impacts upon overall water-related recreational activities. The proposed project is intended to prevent further erosion of islands and loss of vegetation and to facilitate terrestrial and aquatic habitat development. Incidental benefits to sightseeing, fishing, hunting, and rafting activities should occur. Rafters may experience temporary inconveniences until they become familiar with the locations of materials discharged to build the new structures.

(d) Aesthetics.

Stockpiled gravel, screened cobble, and discharged riprap for eco fences, spur dikes, and rock grade control would contrast with the surroundings. Stockpiling of gravel and screened cobble may not occur. However, if it does, visual impacts would be temporary because the material would only be in place a short period of time. Accumulation of woody debris on the piling and rock eco fences would cause their visual contrast to be short-term. Rock grade control would be unobtrusive due to the embeddedness of the material. Contrast of the spur dikes to existing surroundings would be evident to rafters and float fishermen travelling the river and to persons visiting areas that are publicly accessible. Anchored root wad logs would blend in with the setting.

(e) Parks, National Historical Monuments, National Seashores, Wilderness Areas, Research Sites, and Similar Preserves.

No effect.

(f) Actions to Minimize Impacts.

A public information campaign including signage and pamphlets would be implemented to inform river users of the intended project benefits and to alert river users of the construction and presence of the completed structures.

h. Determination of Cumulative Effects on the Aquatic Ecosystem.

The physical character of the Snake River in the project area has been affected in the past by the discharge of fill to construct levees and revetments. This action caused long-term adverse effects upon the river system. The effects include reduction of the width of the floodplain, increased flow velocities through the leveed sections, increased transport of bedload material through the area and erosion of islands, and destruction of wetland and riparian vegetation. Spawning habitat for Snake River fine-spotted cutthroat trout was reduced and the composition, and quality of riparian vegetation outside of the levees continues to change due to the changes in water circulation.

During the winter of 1998-99, Teton County Natural Resource District excavated approximately 6,000 cy of cobble and gravel to construct 3 off-channel pools near the Wilson Bridge. Teton County constructed five pile eco fences, totaling approximately 500 linear feet, on the gravel bars adjacent to the river. The eco fences were placed to trap woody debris, thereby causing the deposition of sediments upon which vegetation may become established. Approximately 1,600 linear feet of channel was also excavated near the bridge to compensate for reductions in flow capacity that would result from the deposition of sediments at the eco fences. The channel capacity excavation and off-channel pool work would have caused temporary non-beneficial effects upon benthic communities, however, recolonization of disturbed areas would occur soon after the disturbance. The long-term effect of Teton County's combined actions would be improvement in water quality due to decreased erosion and improvements in aquatic and terrestrial habitat.

Environmental restoration measures being proposed under the Jackson Hole, Wyoming, Environmental Restoration Project would also have both short- and long-term effects on the aquatic environment. Construction activities would cause minor, short-term impacts to water quality with temporary disturbance of the benthos. However, presence of the completed work would reduce erosion and provide long-term benefits to water quality. Recolonization of the benthos would occur soon after completion of work.

The project would provide primary beneficial cumulative effects by enhancing previously degraded aquatic habitat and by restoring portions of previously destroyed habitat. Rock grade control would provide immediate protection against erosion of the channel bottom. Eco fences and anchored root wad logs would trap other debris and help to reduce velocities within the levied stretch. Channel stabilization pools would also reduce flow velocities and reduce the quantity of bedload material being transported through the levied stretch. Secondary channels would help disperse flows and disperse suspended sediments throughout the floodplain, and off-channel pools would provide habitat for potential spawning and rearing. Bank barbs and kickers provide protection against erosion.

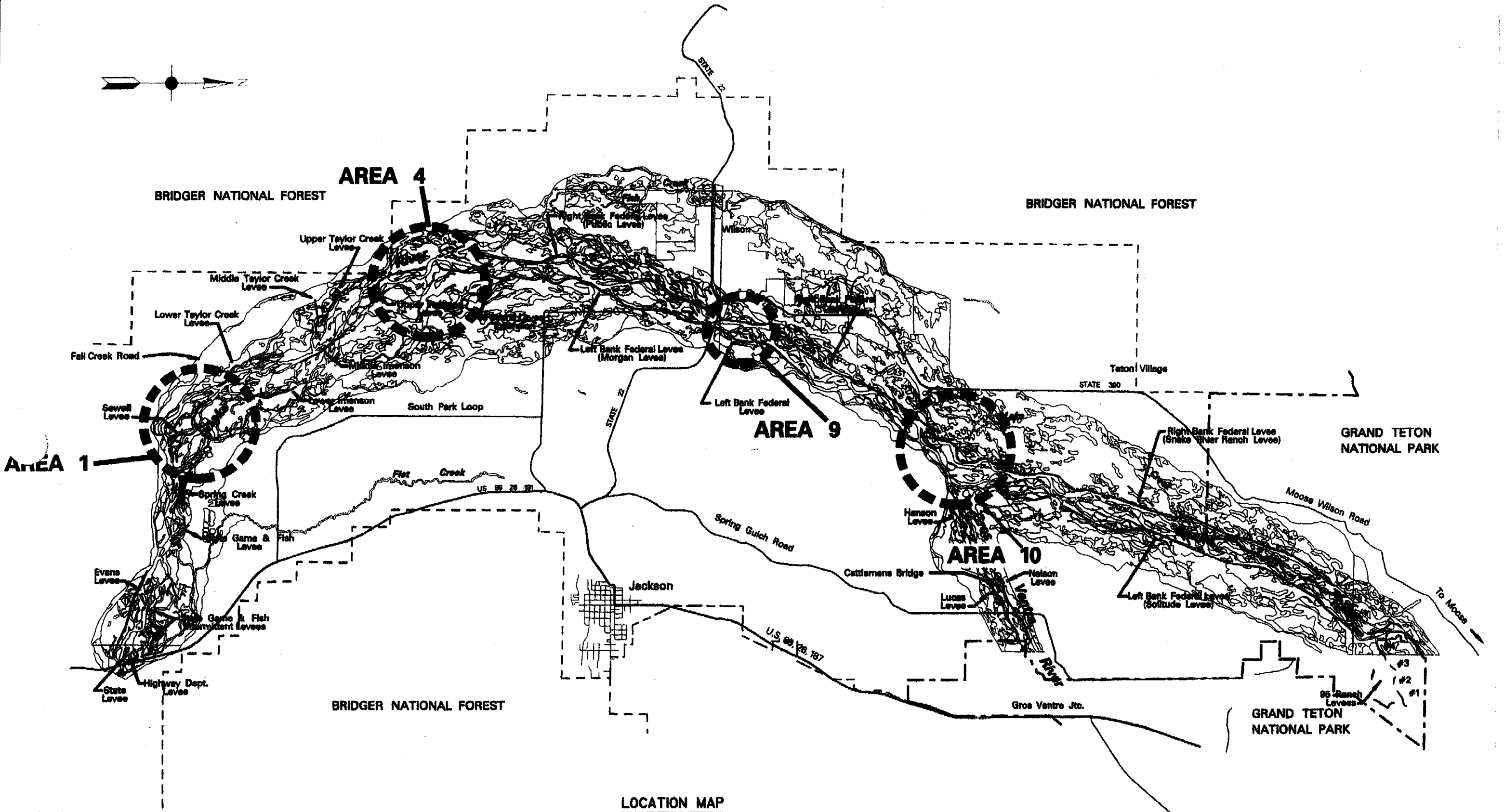
The collective effect of recent actions by Teton County to restore aquatic and terrestrial habitat and those measures proposed in the Jackson Hole, Wyoming, Environmental Restoration Project would reduce the overall adverse effect that past levee and revetment work has had upon the aquatic environment. Cumulatively, the proposed action would reduce erosion of islands and loss of wetland and riparian vegetation and create circumstances for the reestablishment of vegetation.

i. <u>Determination of Secondary Effects on the Aquatic Ecosystem</u>.

Sediments would deposit downstream of pile fences and anchored root wad logs, providing opportunity for establishment of vegetation. Establishment of

vegetation between the levees would help to slow velocities, thereby diminishing the potential for erosion. Scour areas would form around bank barbs and kickers providing resting habitat for Snake River fine-spotted cutthroat trout and other fish. No negative secondary effects are expected to result from the project.

PLATES



LOCATION MAP

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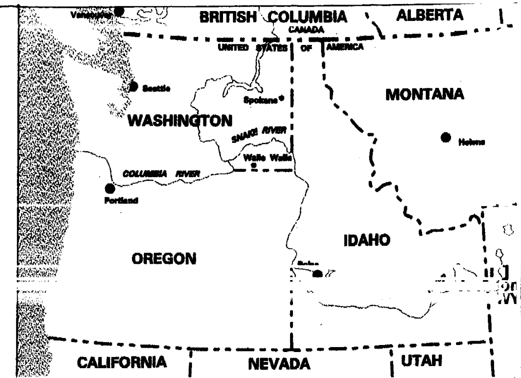


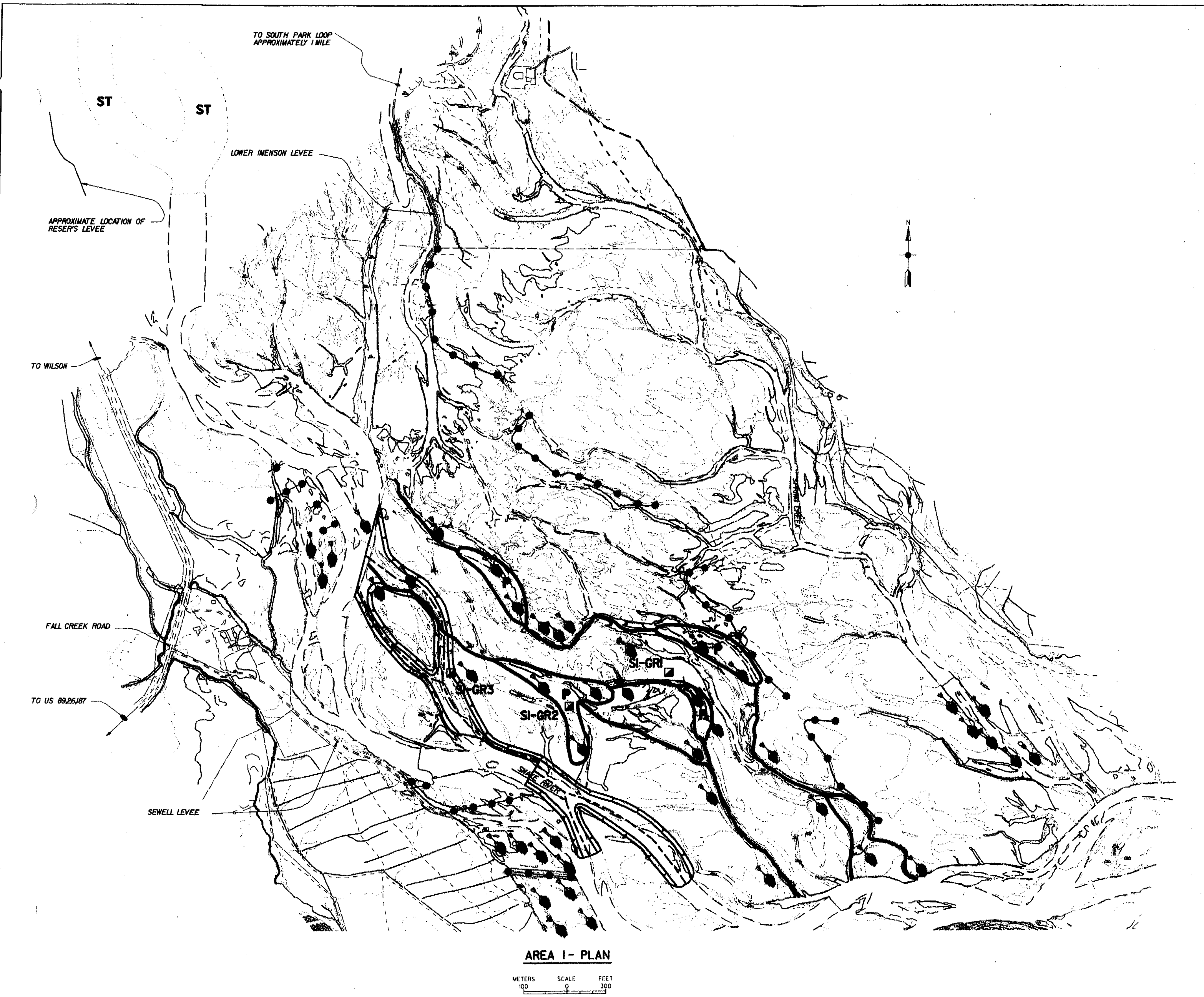
Walla Walla District

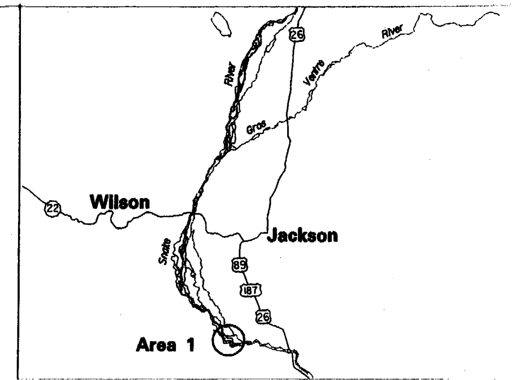
Jackson Hole, Wyoming

Environmental Restoration Project

AREA LOCATIONS

Plate 1





TEST PIT LOCATIONS
SEDIMENT TRAP ST
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ECO FENCES
ANCHORED WOODY DEBRIS
CHANNEL CAPACITY EXCAVATIONS
SUPPLY CHANNELS
LOW CHANNEL BOUNDARY

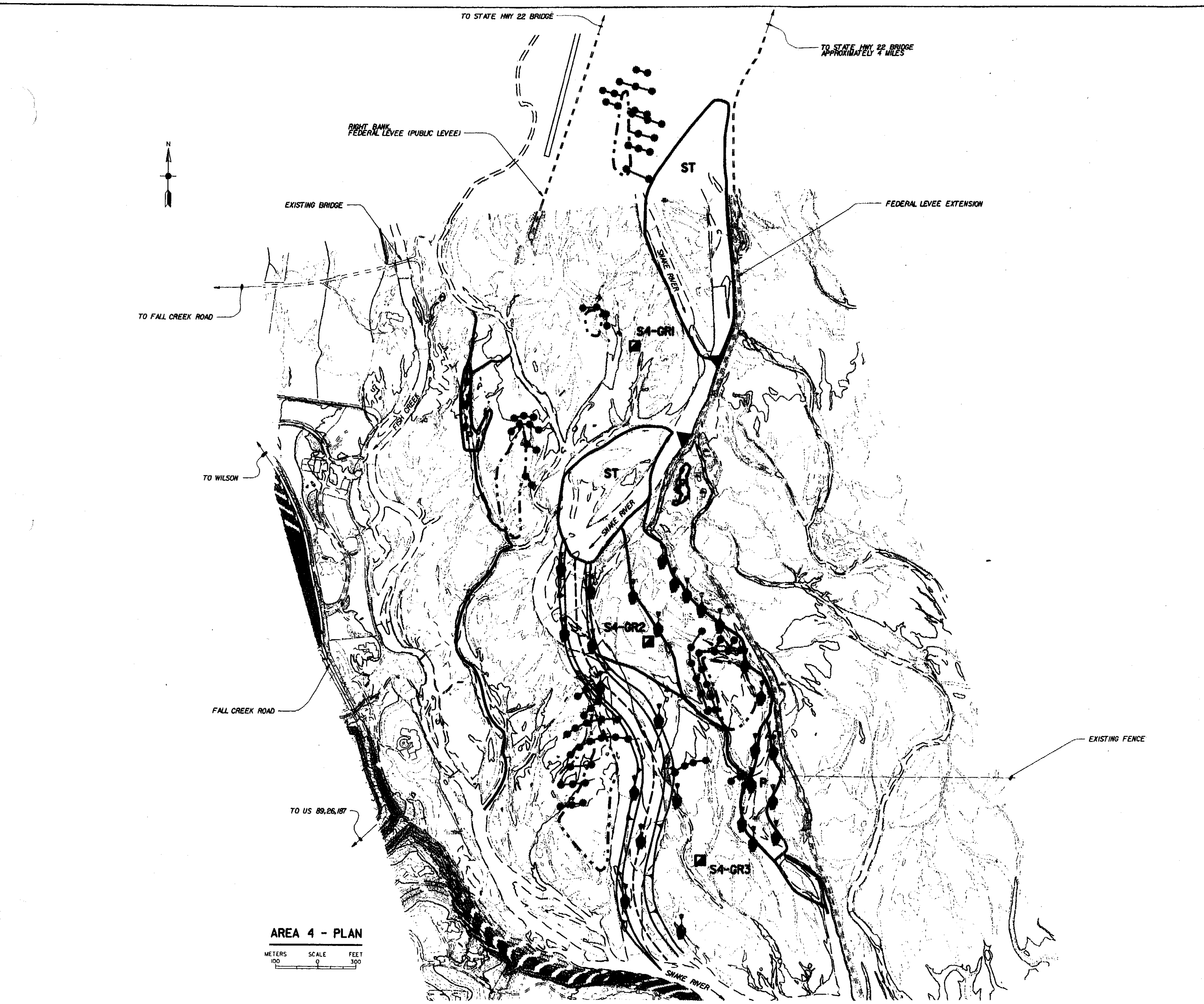
GEOGRAPHIC INFORMATION SYSTEMS

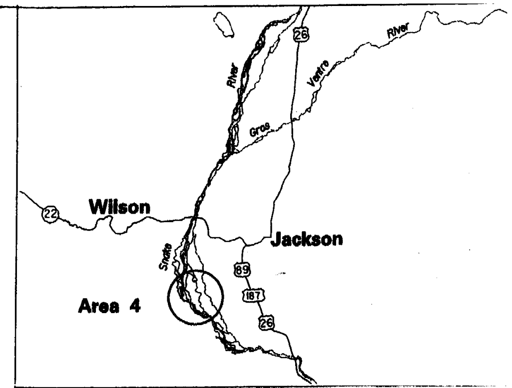
Walla Walla District

Jackson Hole, Wyoming
Environmental Restoration Project

AREA 1 PLAN

Plate 2





SPUR DIKES (REPRESENTS 5 SPUR DIKES)
TEST PIT LOCATIONS
SEDIMENT TRAP ST
SIDE POOLS P
ECO FENCES
ANCHORED WOODY DEBRIS
MATURE TREES
CHANNEL CAPACITY EXCAVATIONS
SUPPLY CHANNELS
LOW CHANNEL BOUNDARY

GEOGRAPHIC INFORMATION SYSTEMS
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Jackson Hole, Wyoming
Environmental Restoration Project

AREA 4 PLAN

Plate 3

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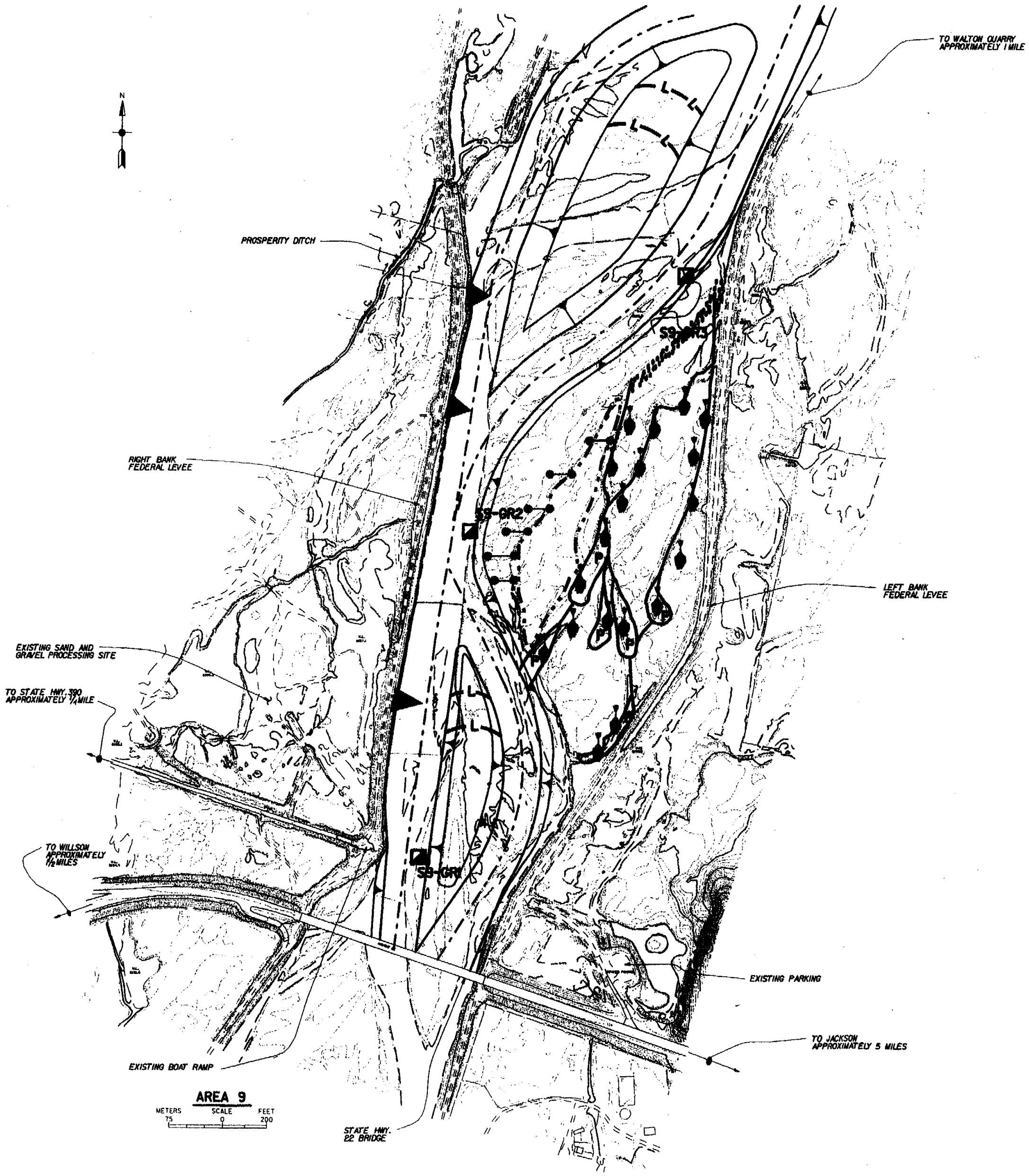
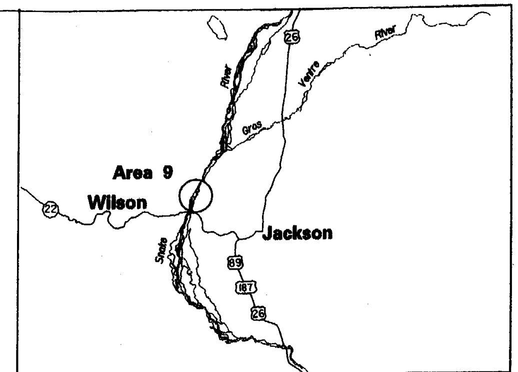




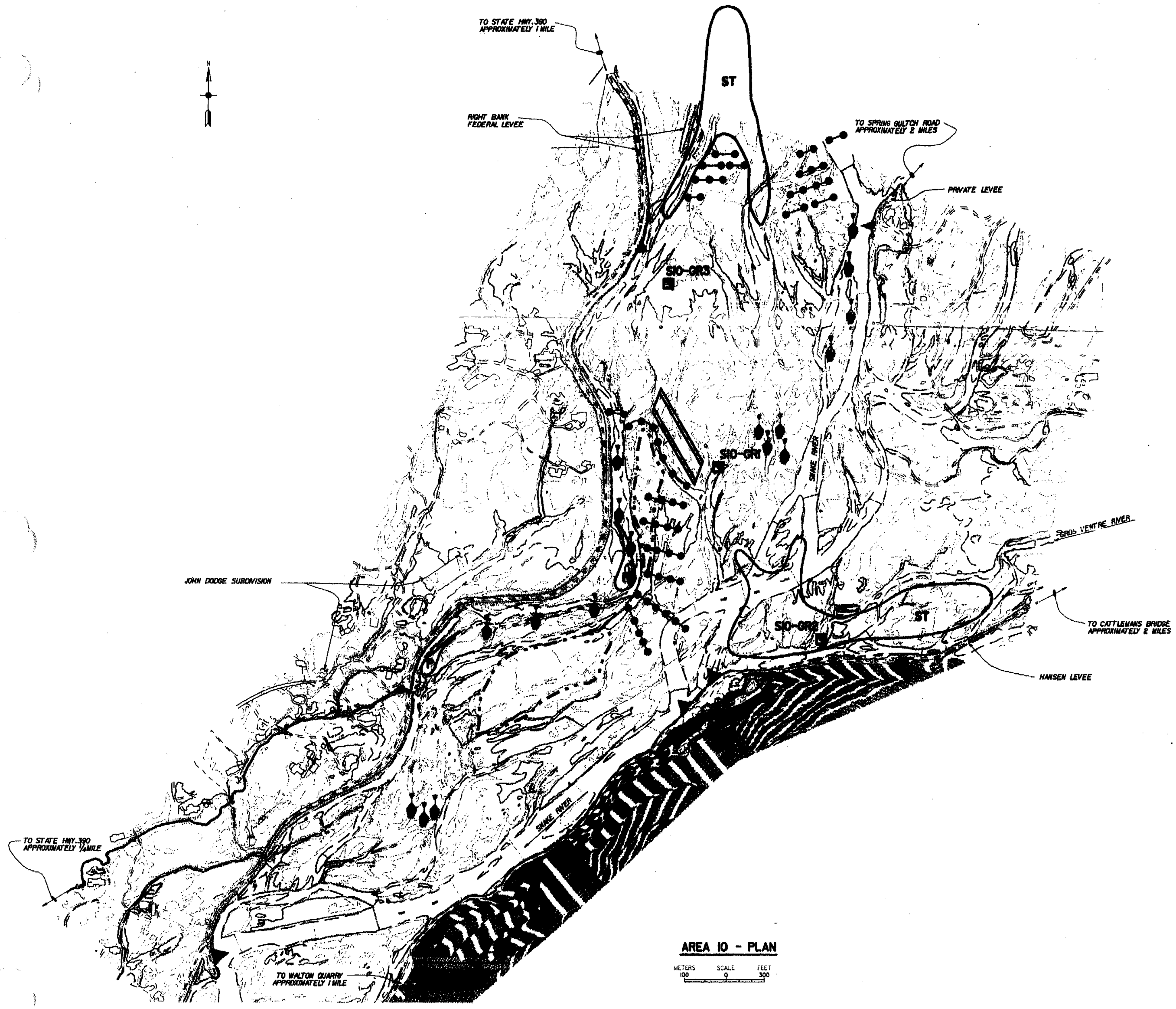
SPUR DIKES (REPRESENTS 5 SPUR DIKES)
TEST PIT LOCATION
SIDE POOLS
STAGGERED LOG PROTECTION
ECO FENCES
ANCHORED WOODY DEBRIS
ROCK GRADE CONTROL
MATURE TREES
CHANNEL CAPACITY EXCAVATIONS
SUPPLY CHANNELS
LOW CHANNEL BOUNDARY

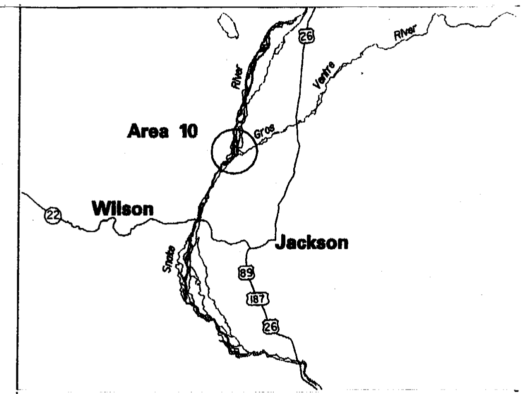
Walla Walla District

Jackson Hole, Wyoming
Environmental Restoration Project

AREA 9 PLAN

Plate 4





TEST PIT LOCATION
SEDIMENT TRAPS
SIDE POOLS
ECO FENCES
ANCHORED WOODY DEBRIS
MATURE TREES
CHANNEL CAPACITY EXCAVATIONS
LOW CHANNEL BOUNDARY

GEOGRAPHIC INFORMATION SYSTEMS

Walla Walla District

Jackson Hole, Wyoming
Environmental Restoration Project

AREA 10 PLAN

Plate 5

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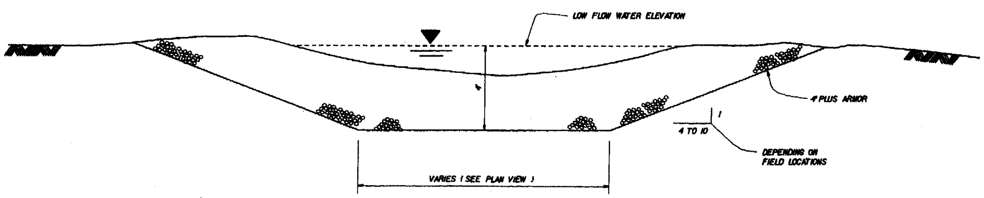
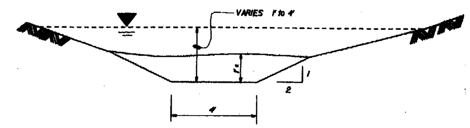
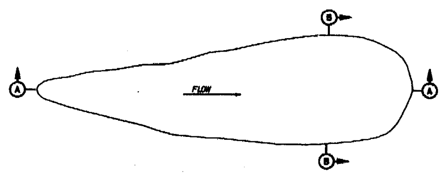


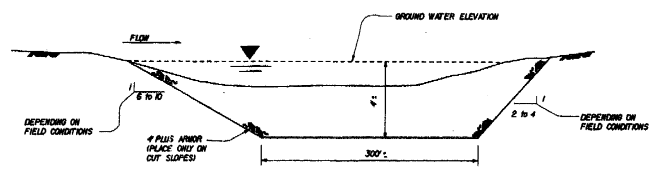
SECTION - SEDIMENT TRAP AND CHANNEL CAPACITY EXCAVATION TYP.



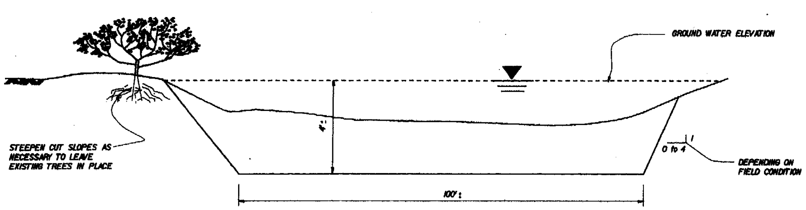
SECTION - SUPPLY CHANNEL TYP.



PLAN - POOL TYP.



SECTION A - POOL TYP.



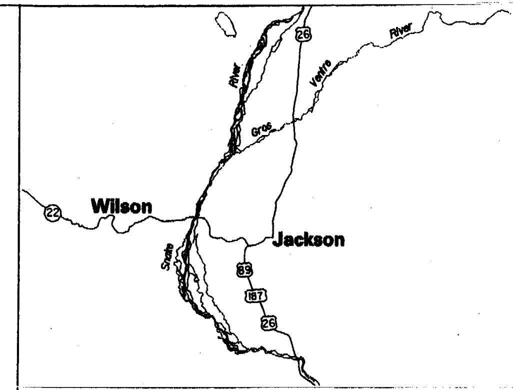
SECTION B - POOL TYP.

NOTES:

1. CUTS THAT INTERSECT EXISTING STRUCTURES SUCH AS LEVEES SHALL BE TERMINATED AT THE STRUCTURE.

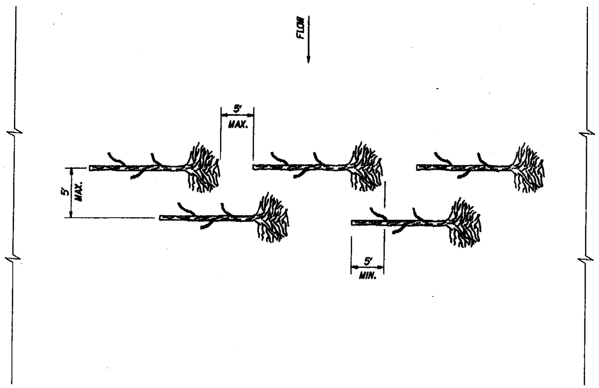
2. CUT SLOPES WILL BE VARIED WITHIN THE RANGE SHOWN ON THE SECTIONS TO PROVIDE CHANNEL DIVERSITY.

3. WOODY DEBRIS WILL BE ANCHORED ON CUT SLOPES APPROXIMATELY ONE ROOT WAD FOR EVERY 60' OF POND PERIMETER.



Walla Walla District

Jackson Hole, Wyoming
Environmental Restoration Project
FLOW IMPROVEMENTS - DETAILS

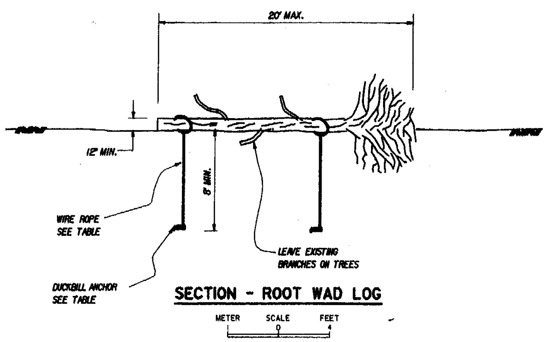


PLAN - STAGGERED ROOT WAD LOG PLACEMENT

NOT TO SCALE

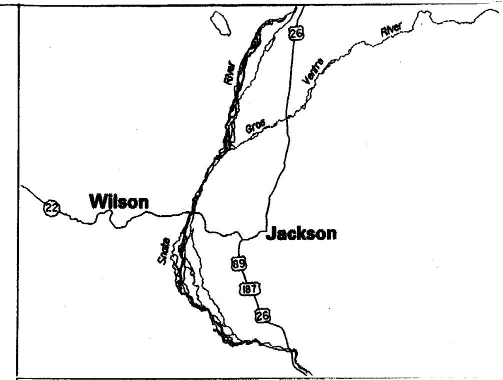
NOTES:

LOGS WOULD BE RANDOMLY STAGGERED TO ALLOW FOR SHORTER LENGTH ROOT WAD LOGS. SPACING AND OVERLAPPING REQUIRMENTS MUST BE FOLLOWED AS SHOWN.



SECTION - ROOT WAD LOG

METER SCALE FEET



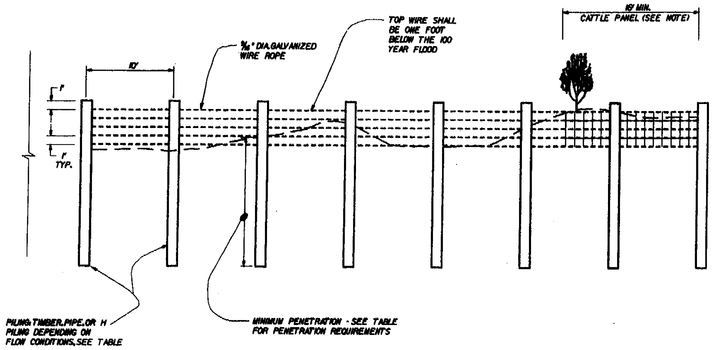
Walla Walla District

Jackson Hole, Wyoming

Environmental Restoration Project

ANCHORED ROOT WAD LOGS - DETAILS

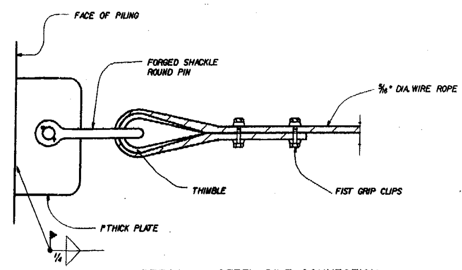
Plate 7



DETAIL - PILE ECO FENCE

METERS SCALE FEET

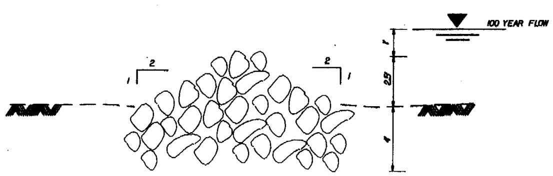
NOTE:
IN AREAS ADJACENT TO WOODED ISLANDS KEY BRUSH FENCE 16' INTO ISLAND AND ATTACH CATTLE PANEL.



DETAIL - STEEL PILE CONNECTION

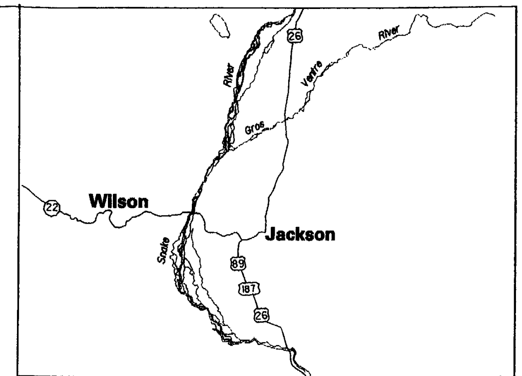
NOT TO SCALE

NOTE:
INSTALL PILE CONNECTION AT EVERY FIFTH PILING AND END PILING. THREAD WIRE ROPE THROUGH INTERIOR PILING.



TYPICAL SECTION - ROCK ECO FENCE

NOT TO SCALE



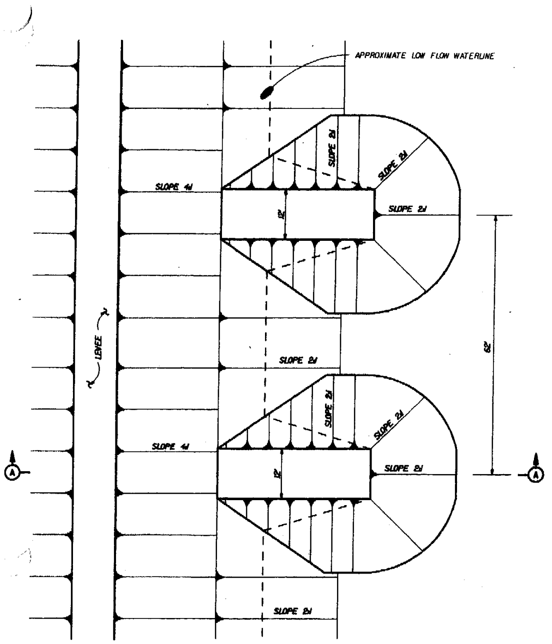
GEOGRAPHIC INFORMATION SYSTEMS

Walla Walla District

Jackson Hole, Wyoming

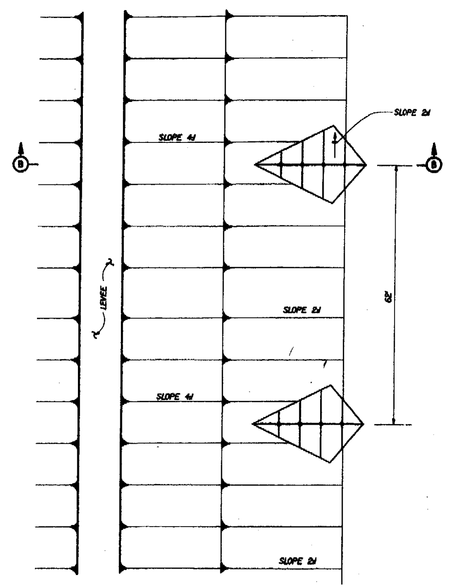
Environmental Restoration Project

ECO FENCE - DETAILS



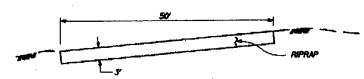
PLAN - KICKERS

METERS SCALE FEET



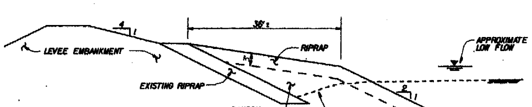
PLAN - BANK BARB

METERS SCALE FEET



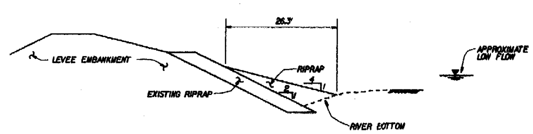
SECTION - ROCK GRADE CONTROL

METERS SCALE FEET



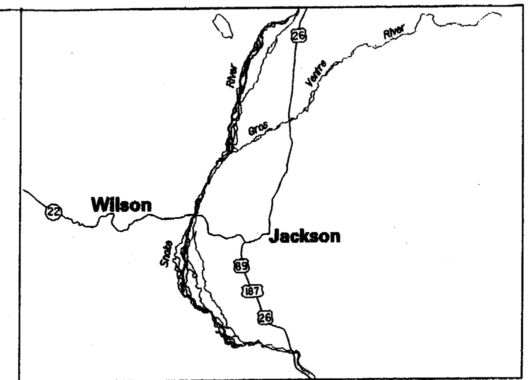
SECTION A - KICKERS

METERS SCALE FEET



SECTION B - BANK BARB

METERS SCALE FEET



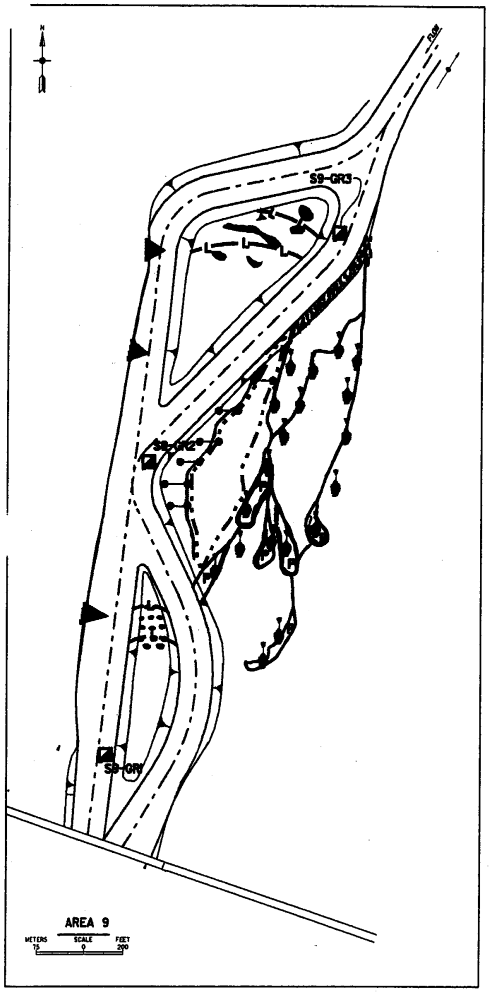
GEOGRAPHIC INFORMATION SYSTEMS

Walla Walla District

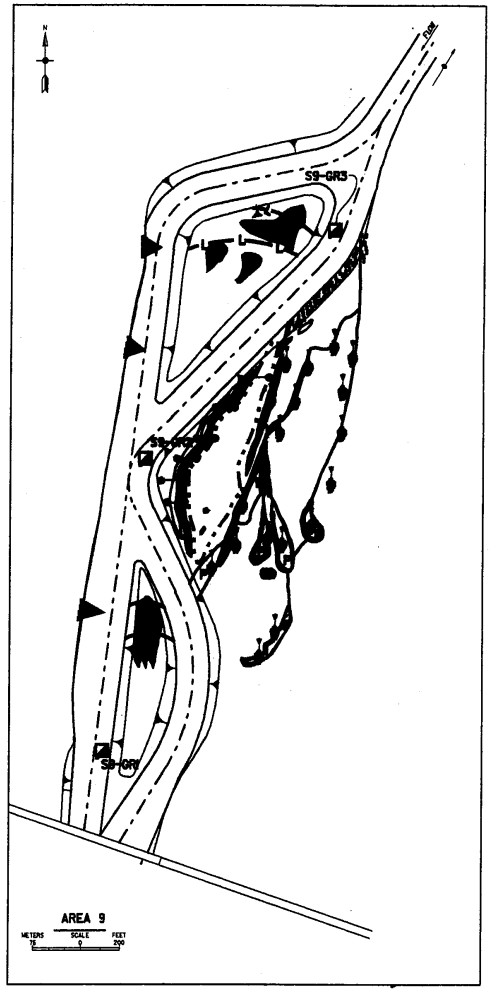
Jackson Hole, Wyoming

Environmental Restoration Project

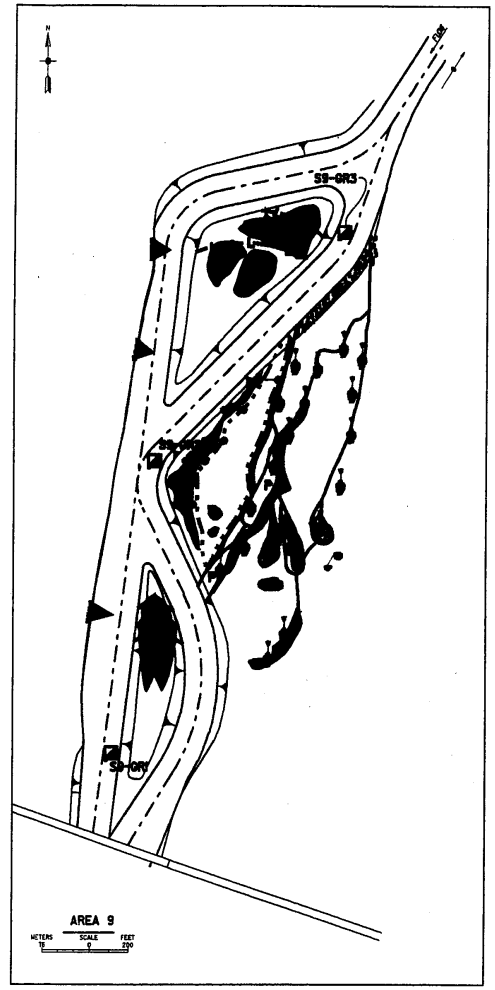
SPUR DIKE - DETAILS



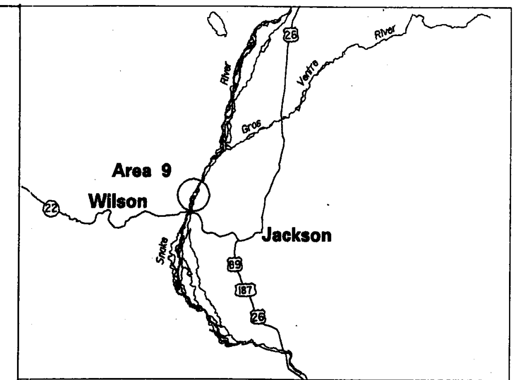
5 YEAR



25 YEAR



50 YEAR



- SPUR DIKES (REPRESENTS 5 SPUR DIKES)
- TEST PIT LOCATION
- SIDE POOLS
- STAGGERED LOG PROTECTION
- ECO FENCES
- ANCHORED WOODY DEBRIS
- ROCK GRADE CONTROL
- MATURE TREES
- CHANNEL CAPACITY EXCAVATIONS
- PALUSTRINE SHRUB/SCRUB (PSS)
- PALUSTRINE FOREST (PF)

Walla Walla District

Jackson Hole, Wyoming
Environmental Restoration Project

AREA 9 PROJECTED VEGETATION CHANGES

Plate 10

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Appendix F
to the Environmental Assessment

JACKSON HOLE, WYOMING ENVIRONMENTAL RESTORATION PROJECT

MONITORING PLAN

April 2000

1.0 BACKGROUND

Levees constructed under the Jackson Hole, Snake River, Wyoming levee project reduce the potential for flood damage within adjacent areas of the Snake River valley. The levees also significantly changed the physical character of the river system and contributed to the loss of environmental resources through reduction of the floodplain and reductions in habitat diversity. Effects include changes in channel configuration that have eliminated natural braiding and reduced the number and size of islands. High velocity flows erode the river channel, islands, and vegetation along the banks and on islands. Effects to aquatic habitat include reduction of the following: low energy resting habitat, in-stream large woody debris, vegetative cover, and high quality tributary spring creeks essential to some species for spawning. Effects to riparian habitat include the reduction of shrub-willow/cottonwood habitat important in the life cycles of many species of wildlife.

The Jackson Hole, Wyoming Environmental Restoration Study was authorized to investigate methods to restore lost fish and wildlife habitat resulting from construction, operation, and maintenance of the Jackson Hole levee project, including levees constructed by non-Federal interests, and methods to reduce the cost of operating and maintaining the levees. Measures identified by the study focus on methods to dissipate or redirect the energy of high velocity flows in order to reestablish aquatic and terrestrial habitat. These measures include construction of eco-fences, sediment traps, spur dikes (bank barbs and kickers), and off channel pools with connecting side channels. Detailed descriptions of all restoration features are presented in the main feasibility report.

2.0 PURPOSE

The purpose of this Monitoring Plan is to assess the effectiveness of the restoration features on aquatic and terrestrial resources. Monitoring will focus on the functional performance of the restoration tools and on the effects on aquatic and terrestrial habitat. Monitoring would also identify the need for maintenance on various structures. Results obtained through monitoring will enable the Corps of Engineers and local sponsor, through coordination with local agencies, regulatory authorities, landowners, and other interests, to make informed decisions concerning management of the project to achieve planned performance goals. The monitoring plan will also build an information base to support future restoration decisions regarding the design and performance of the restoration measures.

3.0 MONITORING PROCEDURES

Monitoring procedures have been organized in this plan to differentiate between project performance and maintenance requirements. Project Performance monitoring will document fish and wildlife habitat conditions at construction sites prior to construction and will assess the long-term changes in riparian and aquatic

habitat. Maintenance monitoring will be performed to assess maintenance needs for each restoration tool. Monitoring for the Progressive Plan will be performed in a similar manner to Initial Plan monitoring.

3.1 Project Performance Monitoring

Monitoring of terrestrial resources would focus upon the effects of the restoration project on riparian vegetation and wildlife habitat. Aquatic resources monitoring would identify effects of restoration tools upon cutthroat trout habitat. A Corps representative would conduct this monitoring.

Vegetation transects and Habitat Evaluation Procedures (HEP) would be used to monitor for signs of vegetative succession toward the palustrine scrub-shrub (dominated by willows) and palustrine forest (dominated by cottonwood) ecotypes. Models for yellow warbler and song sparrow would be used. These models work well for riparian vegetation. Habitat Evaluation Procedures (HEP) were utilized during the project study to identify existing vegetation and assess changing conditions in vegetation loss or gain. Vegetation transects depict trends by the change in cover and measure site specific changes. HEP shows the change in habitat units and measures site specific and regional changes.

Monitoring efforts occurring during the first five years of monitoring would be documented and presented a Project Performance Report. The report would document monitoring efforts and results for all four of the initial restoration sites. Periodic reports will also be written for monitoring during the Progressive Plan monitoring years.

Vegetation Transects

The vegetation transects will be 30 meters long, running parallel to the eco-fences. Three layers of vegetative information would be recorded along this transect. A transect would start in the area downstream of the eco-fence and proceed to the adjacent upland. The transect may be extended to 60 meters if needed. All vegetation cover percentages would be recorded by line intercept. Herbaceous vegetation, shrubs, and trees will have cover percentages recorded this way. Photos would be taken from one end of the transect looking toward the other end of the transect. Three photos would be taken at each end, with each series generally consisting of one photo-view perpendicular to the transect and the remaining two offset by approximately 15-degrees. Other transects would be run through log placements and along secondary channels. At least two transects in each of these areas would be recorded. Transects would be measured and recorded during mid-July each year.

Aerial Photography and Cover Typing

Aerial photography would be obtained for each of the constructed sites when available and in the fifth year of monitoring. Cover types would be mapped and measured over all of the work sites. Palustrine forest and palustrine scrub-shrub types would be singled out for use with the HEP. Field HEP parameters would be measured at all work sites during the summer of the year aerial photography is taken. Field work would use the same methodology for the abbreviated HEP performed in 1996 (Yellow Warbler and Song Sparrow were the indicator species used for this analysis). Habitat suitability indices (HSI) would be calculated for all palustrine forest and palustrine scrub-shrub habitats. Habitat units would be calculated by multiplying the HSI value by the area of habitat.

Cutthroat Trout Over-wintering Habitat Evaluation

Cutthroat trout over-wintering habitat will be estimated for each initial restoration site during the first and fifth years of monitoring. If the Progressive Plan is implemented, pre-construction baseline habitat data will be collected. Future habitat measurements will be conducted periodically to assess the effectiveness of the restoration tools toward maintaining over-wintering habitat. The habitat evaluation methods will estimate the quantity and quality of over-wintering pool habitat available for adult and juvenile cutthroat trout in the selected study sites during the critical winter period. Data gathered in this evaluation will be incorporated into the Project Performance Report.

The same over-wintering pool habitat evaluation procedures used in 1998 for the pre-construction evaluation will be used, including photo documentation at all survey point locations. The evaluation of the habitat types and attributes being considered will allow for a determination of habitat benefits gained through this project. Evaluations will be carried out in the fall during low flow conditions, usually in early October. Low flow conditions are important because over-wintering habitat during low flow is one of the most critical limiting factors on cutthroat in the upper Snake River.

3.2 Maintenance Monitoring

Maintenance monitoring will assess the performance of restoration. A Corps representative would conduct Maintenance monitoring. All structures will be photographed annually during monitoring and immediately following implementation of any maintenance measures that may result. Hydrologic monitoring will track the performance of the tools in relation to their intended purpose and track the effects of river flows upon the restoration tools.

When indicated, the status of restoration effects and performance of all features would be facilitated by dated photographic documentation. Photographic documentation would include the establishment of photo points throughout each project site. The location of the photo points and field of view would be mapped

and location markers placed in the field where possible. This may be done with permanent stakes and a compass, or other means that would insure consistent photographic fields of view throughout the monitoring period. All construction sites would be photographed prior to initiation of construction. All constructed features would be photographed upon the completion of construction to serve as a basis for future comparison of vegetative growth and sedimentation as appropriate.

Observed damages, required repairs, and observed physical changes in the various restoration features will be presented in an annual Maintenance Monitoring Report. The report would document maintenance monitoring efforts occurring during the 5 years of cost-shared monitoring. The report will include results observed, photographs, and subsequent implemented maintenance.

4.0 MONITORING COSTS

The cost of project performance monitoring and maintenance monitoring would be shared between the Corps and local sponsor and is limited to 4 per cent of the total construction cost. The final monitoring plan will be identified for each construction area during the PED phase.

APPENDIX I

FISH AND WILDLIFE

OF THE

JACKSON HOLE, WYOMING, ENVIRONMENTAL RESTORATION
FEASIBILITY STUDY

Appendix I
Jackson Hole Environmental Restoration Study Fish and Wildlife

Aquatic and terrestrial resources on the Snake River in the Jackson Hole, Wyoming, area have been impacted by human induced changes to fish and wildlife habitat. Stream flow alterations from Jackson Lake and flood control levees have changed stream morphology and dynamics, which the associated flora and fauna evolved with. Habitat improvements in the area have a high potential to increase fish and wildlife populations. By protecting areas from the erosive action of high flows, riparian vegetation will be able to complete its life cycle. This includes early stages that increase the amount of nutrients and insects available to the stream, reaching maturity to shade the stream, and eventually falling into the stream creating pool habitat. Habitat improvement sites were selected based on several criteria, such as existing habitat condition, surrounding habitat condition, and probability of successful habitat improvements. Affected species, evaluation methods, and projected habitat conditions are presented in the following sections.

1. AQUATIC RESOURCES.

a. Cutthroat Trout.

Snake River fine-spotted cutthroat trout (*Oncorhynchus clarki ssp.*) are the main fish species of concern in the project area. The Wyoming Game and Fish Department designate much of the Snake River in the project area as a Class 1 or a blue-ribbon trout stream. This indicates that the river is of national importance as a trout stream and should receive high priority for protection (Kiefling 1978, USACE 1989). Spawning habitat is considered one of the major limiting factors for Snake River fine-spotted cutthroat trout (USFWS 1988, Erickson 1980, USACE 1989). Most cutthroat spawning occurs during March through June in the spring creeks that enter the river along the project reach (Kiefling 1978, USACE 1989). Access to spring creeks and side channels used for spawning has been severely reduced due to construction of flood control levees. In addition to access restrictions, flow patterns within spawning channels have been altered, which further reduces useable spawning habitat. The openings of many of these spring creeks are currently blocked from floods by levees. Spawning is limited or nonexistent in the main channel of the Snake River because of several factors. These include spring flows carrying high bedloads, high turbidity, human-induced modifications of the channel, and a cobble substrate that is typically too large for trout spawning (Kiefling 1978, Erickson 1980, USFWS 1988, USACE 1989). The Wyoming Game and Fish Department, local environmental groups, and landowners have been working to enhance spawning areas for several years. Much of their work has been very successful in increasing the number of cutthroat redds on private property in spring creeks (Kiefling 1986).

Another factor limiting cutthroat populations is the lack of overwintering habitat. During winter low-flow periods pools with cover are often very important to cutthroat trout (Lestelle and Cederholm 1984, Murphy *et. al.* 1984, Swales *et. al.* 1986, Bustard and Narver 1975b, USACE 1989). In many areas it has been shown that structure formed by large woody debris contributes significantly to the total habitat in

streams for trout and salmon (USACE 1989). Results from an instream flow study conducted above the project reach of the Snake River suggest that low-flow overwintering habitat is limited (Annear 1989, USACE 1989). Because of a lack of slow, deep pools, or other flow diversions, low flows and ice formation can severely limit habitat usable by cutthroat during the winter. Lack of overwintering habitat also appears to cause high mortality in young age classes of cutthroat in the Snake River system (Kiefling 1978).

Overwintering habitat for cutthroat trout was selected as the parameter to measure and for future comparisons because it is the limiting factor that will be increased by the proposed project. Baseline cutthroat overwintering habitat data was measured in October of 1998. It is important that habitat data is collected at the same time of year annually for consistent comparisons between years. Overwintering habitat was defined as water with low velocity; some form of cover (depth, surface turbulence, overhanging bank, wood, *etc.*); and a depth greater than 1.5 feet (0.46 meters). Criteria used for ranking overwintering pool habitat came from the US Fish and Wildlife Service "Habitat Suitability Index Model: Cutthroat Trout" (Hickman and Raleigh 1982). Pool class is important for determining the relative cutthroat habitat value for individual pool areas. Pools of different classes provide different amounts and quality of cover. Pool classes associated with the highest standing crops of trout are assumed to be optimum.

First class pools (figure 1) are large and deep. Pool depth and size are sufficient to provide a low velocity resting area for several adult trout. More than 30 percent of the pool bottom is obscure due to depth, surface turbulence, or the presence of structures (*e.g.* logs, debris piles, boulders, or overhanging banks and vegetation; or the greatest pool depth is $\geq$ 2 meters deep in streams > 5 meters wide).

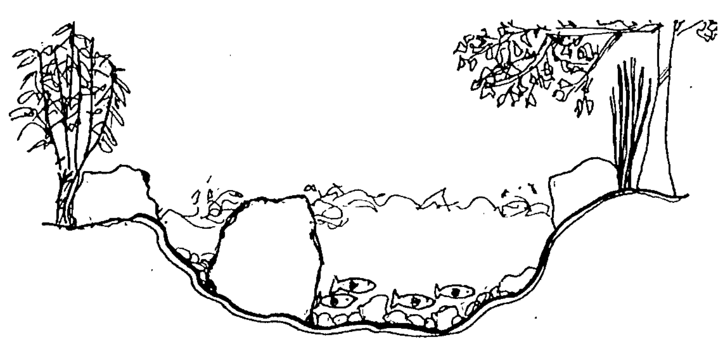

Figure 1. Class 1 Pool

Second class pools (figure 2) have moderate size and depth. Pool depth and size are sufficient to provide a low velocity resting area for a few adult trout. From 5 to 30 percent of the bottom is obscure due to surface turbulence, depth, or the presence of structures. Typical second class pools are large eddies behind boulders and low velocity, moderately deep areas beneath overhanging banks and vegetation.

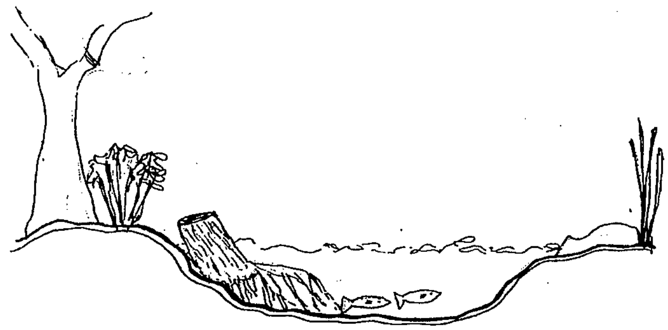

Figure 2. Class 2 Pool

Third class pools (figure 3) are small or shallow or both. Pool depth and size are sufficient to provide a low velocity resting area for one to very few adult trout. Cover, if present, is in the form of shade, surface turbulence, or very limited structure. Typical third class pools are wide, shallow pool areas of streams or small eddies behind boulders. Virtually the entire bottom area is discernible (Hickman *et. al.* 1982).

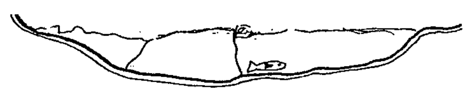

Figure 3. Class 3 Pool

There was an estimated 10 655 square meters (2.63 acres) of pool habitat in the evaluated sections of the study areas. Table 1 lists the distribution of pool habitat type by area.

Table 1. Square meters of pool habitat types.

Area	Pool Class	Pool Area
1	3	100
	2	60
	1	920
	Total	1 080
4	3	2 175
	2	1 100
	1	1 030
	Total	4 305
9	3	170
	2	580
	1	1 400
	Total	2 150
10	3	400
	2	420
	1	2 300
	Total	3 120
	Grand Total	10 655

Systematic methods were used to measure a sample of each study area. The amount of overwintering habitat was estimated at approximately 12 to 24 points in each area near proposed work locations. The exact channel alignment can change annually so it is impossible and impractical to survey exactly the same locations for aquatic habitat over time. Photographs were taken at each survey point and the aspect was noted. Figure 4 is an example from area 1 showing the locations of the survey points. Figures 5 and 6 are photos taken at survey point 6 in area 1. Distance measurements were made with an optical rangefinder. Depth and percent cover measurements were measured if access was available and estimated if the pool was too difficult to wade to. Points were 100 paces apart, perpendicular to the main channel. One square meter of overwintering habitat received a value of one Habitat Unit (HU). The relative quality (Pool Class) of overwintering habitat was also recorded. To keep calculations simpler, total habitat areas for each study area were summed regardless of quality. However, future comparisons can be made with reference to the quality of overwintering habitat as well as the quantity.

Figure 4. Approximate survey point locations in Area 1. (The exact channel alignment differed slightly during the assessment than in this 1996 photograph.)

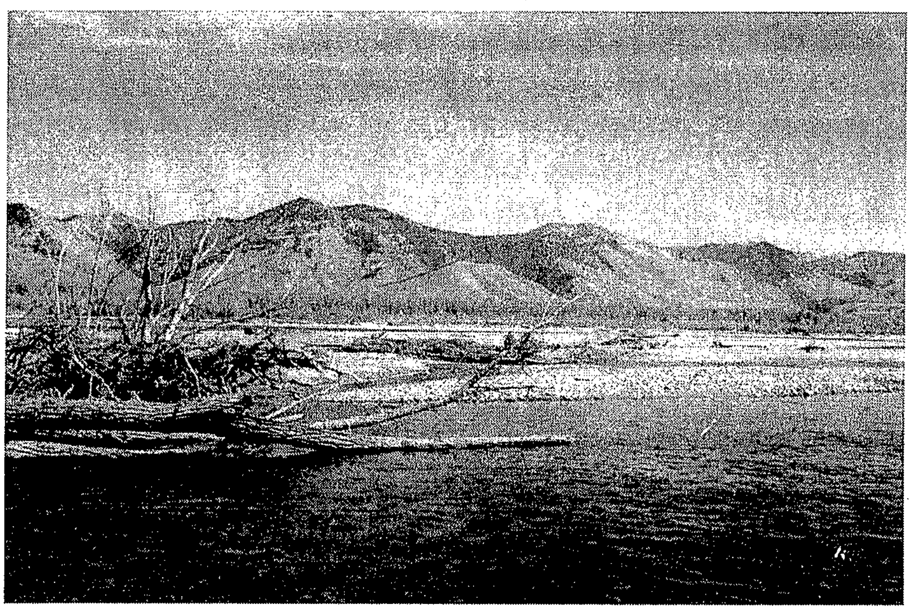

Figure 5. Survey point 6 on the right bank in Area 1 looking northeast.

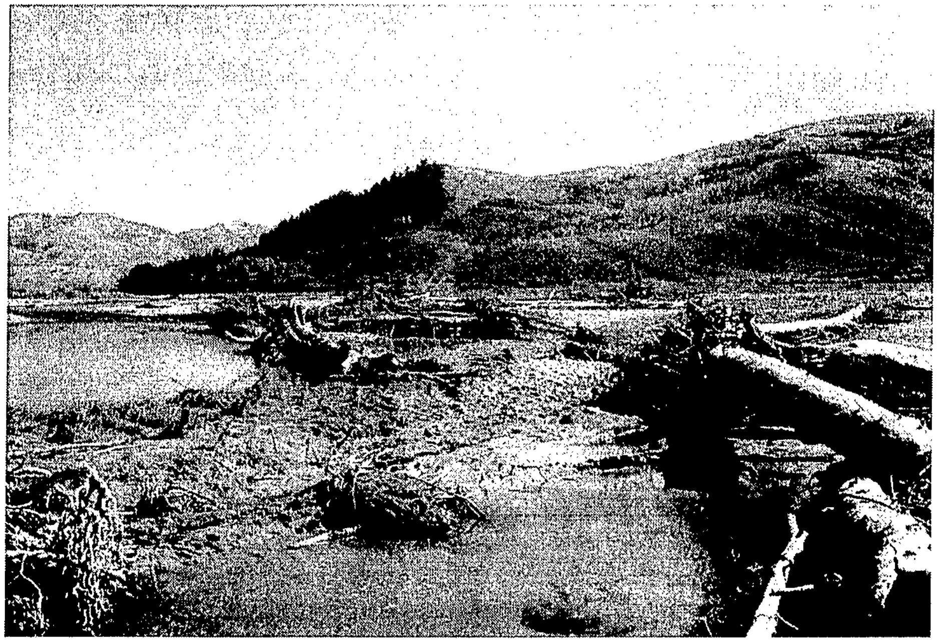

Figure 6. Survey point 6 on the right bank in area 1 looking Southeast. Note the high amount of large woody debris deposited after the last high flow. Much of this debris came from a once highly vegetated area a few hundred yards upstream that is now only bare cobbles.

The total amount of overwintering habitat recorded for each site represents the sum of the amount seen from each sample point. Comparisons can be made with future habitat data that is to be collected in a similar manner in the same general areas. If the main channel shifts dramatically, data can still be compared directly by using the same number of sample points at 100 pace intervals, perpendicular to the main channel.

b. Projections.

Future overwintering habitat levels were estimated by using an estimated overwintering habitat area value that would be created by any of the proposed structures. The spurdike/kicker structure was the only tool assumed to create overwintering habitat. These structures will create a scour hole with greater water depth and lower velocity on the downstream side of them. The other tools are assumed to be out of the water during low winter flows. The trees, which the other tools may provide in the long term, did receive credit towards future overwintering habitat levels, but at a small percentage of the spurdikes/kickers. Trees that will grow in the silt accumulation zones (around eco-fences) will not provide overwintering habitat unless they mature and later fall into the river.

This project is designed to increase the amount of overwintering habitat available to trout as well as to protect existing riparian areas from frequent high water events. This work along with other local spawning gravel enhancement projects could

increase the cutthroat trout population. Cutthroat trout are known to travel long distances between habitat types (Brown *et. al.* 1995, Bjornn *et. al.* 1964). Spawning gravel enhancement even several miles from overwintering habitat enhancement can work together to benefit the cutthroat population. Figure 7 summarizes overwintering pool habitat conditions and projections for the four study areas.

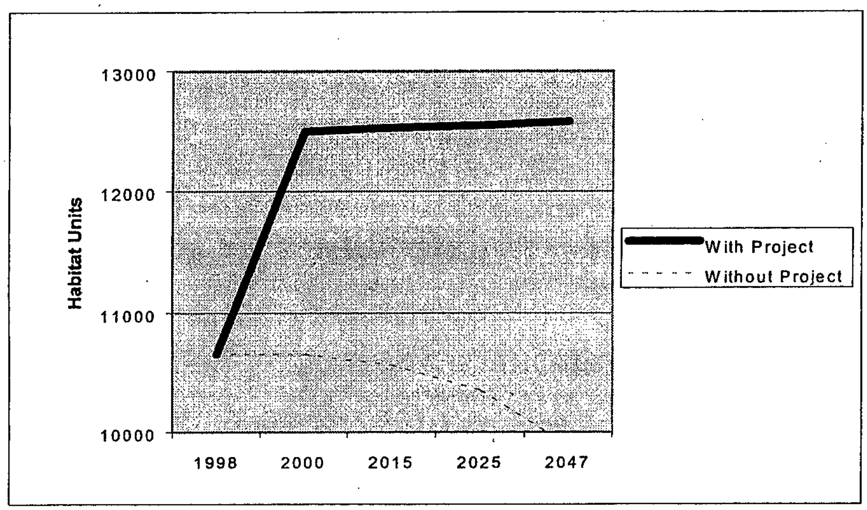

Figure 7. Summary of Overwintering Habitat for the Proposed work.

c. Other Game Fish Species.

Mountain whitefish (*Prosopium williamsoni*) are abundant in the Snake River. This species may compete with cutthroat for food, but only at a limited level in the Snake River (Kiefling 1978, USACE 1989). Other salmonids are present in the region, but in relatively low abundance. They include brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*), rainbow trout (*Oncorhynchus mykiss*), and lake trout (*Salvelinus namaycush*) (Kiefling 1978, USFWS 1988, USACE 1989). An increased amount of overwintering habitat would also be used by these species. However, the overall population distribution is not expected to change.

d. Non-Game Fish Species.

Suckers (*Catostomids*) provide an important food source for bald eagles (USFWS 1988, USACE 1989). Sculpins (*Cottids*) are a major prey item for Snake River cutthroat trout (Kiefling 1978). Five species of minnows (*Cyprinids*) are present in the Snake River. These small fish are also used as prey by trout (Kiefling 1978, USACE 1989). It is not expected that this project will have a noticeable population affect on these species.

e. Aquatic Invertebrates.

Aquatic invertebrates are a primary food source for all carnivorous fish in the Snake River. A variety of species are present. Kroger (1967) found that 98 percent of the sampled biomass was comprised of mayflies (*Ephemeroptera*), true flies (*Diptera*), caddisflies (*Tricoptera*), and stoneflies (*Plecoptera*). Four genera of caddisflies produce the highest biomass of insects in the Snake River. Kiefling (1978) found a similar composition and abundance in the Gros Ventre River.

Most aquatic invertebrates identified in the Snake River are herbivores and detritivores, although a few are carnivorous (Kroger 1967). Of the six most abundant species of caddisflies, three are herbivorous and three are slightly carnivorous. The mayflies are predominately herbivorous. The stoneflies have the most varied diet, being both herbivorous and carnivorous. The true flies are generally herbivorous. Their larvae are an important food source to carnivorous invertebrates.

f. Aquatic Plants and Algae.

True aquatic communities are supported by standing or flowing water year-round, and are composed primarily of white buttercup (*Ranunculus aquatilis*), yellow buttercup (*R. cymbalarai*), speedwell (*Veronica americana*), waterweed (*Elodea sp.*), pondweed (*Potamogeton sp.*), watercress (*Rorippa nasturtium-aquaticum*), water milfoil (*Myriophyllum sp.*), mare's tail (*Hippuris*), and duckweed (*Lemna sp.*). White buttercup commonly forms large mats in shallow, standing water. Mat-forming algae is also common in shallow, stagnant ponds. Liverwort and stonewart species are also common (USACE 1989).

The cobble-gravel bottom communities are dominated by foxtail (*Alopecurus aequalis*), silverberry (*Eleagnus commutata*), willow (*Salix sp.*), timothy (*Phleum pratense*), sedge (*Carex sp.*), muhly (*Muhlenbergia*), sweet clover (*Melilotus officinalis*), horsetail (*Equistum sp.*), and dock (*Rumex sp.*) (USACE 1989).

2. TERRESTRIAL RESOURCES.

The vegetation in the upper Snake River drainage near Jackson, Wyoming, is typical of the central, Rocky Mountain region. Upland vegetation types in the area include: sagebrush-grassland, lodgepole pine/Douglas fir, and subalpine fir/Engleman spruce (USACE 1994). The sagebrush-grassland type occurs on the glacial outwash plains and terraces above the floodplain. This type is dominated by sagebrush (*Artemisia tridentata*) and perennial grasses, [*e.g.*, wheatgrasses (*Agropyron* spp.); fescues (*Festuca* spp.); and bluegrasses (*Poa* spp.)]. Forests dominated by lodgepole pine (*Pinus contorta*) occur at lower elevations [1 920 to 2 380 meters (6,300 to 7,800 feet)] along rivers and above the glacial outwash plain. Douglas fir (*Psuedotsuga menziesii*) intermixes with lodgepole pine, but is generally dominant only on ridge tops and east-facing slopes. Subalpine fir (*Abies lasiocarpa*) and Engleman spruce (*Picea

englemanii) dominate higher elevation [2 380 to 3 050 meters (7,800 to 10,000 feet)] forests (USACE 1994).

The floodplain along the Snake River and its tributaries includes mixed deciduous/ coniferous forests and wetlands. Floodplain forests consist of narrow-leaf cottonwood (*Populus angustifolia*) and willow (*Salix* spp.) intermixed with Engleman and blue spruce (*Picea pungens*). Wetlands occur where the water table is high enough to support hydrophytic plants (*i.e.*, plant species that grow in water or on a substrate that is at least periodically deficient in oxygen as a result of excessive water content). These include three major types: palustrine scrub-shrub, palustrine emergent, and aquatic bed (USACE 1994). The palustrine scrub-shrub wetlands are found primarily on stable gravel bars and dikes and are dominated by willow and mountain alder (*Alnus incana*). The palustrine emergent wetland's primary species are sedges (*Carex* spp.), cattails (*Typha* spp.), and bulrush (*Scirpus* spp.) The aquatic bed wetlands dominant species depend on bottom substrate. Aquatic beds along shorelines tend to support watercress. Pondweed is common in streams or ponds with silt bottoms. Ballhead waterleaf (*Hydrophyllum capitatum*) occurs in rocky substrates (USACE 1994).

Over 30 rare plant species tracked by the Wyoming Natural Diversity Database (WYNDD) occur in the vicinity of Jackson Hole Levees (table 2; USACE 1994). None of these species are Federally listed or proposed as threatened or endangered, but three are protected on U.S. Forest Service (USFS) lands. Those species listed in table 2 are considered extremely rare (5 or fewer occurrences) to rare (21 to 100 occurrences) in Wyoming or regionally. It is highly unlikely any of these species occur within the work areas between the levees. The west side of area 4 and the east side of Area 1 have wetland habitat that includes moist soil plants that may include those listed in table 2 (USACE 1994). Care must be taken to minimize these disturbances. Monitoring for noxious weeds will be needed to ensure they do not spread within areas above the primary flood zone of the river channel.

3. <u>HISTORY AND GENERAL NEED FOR WILDLIFE HABITAT IMPROVEMENT</u>.

The installation of the levees has reduced both the quality and quantity of wildlife habitat within the levied reaches of the Snake River. Between 1956 and 1986 the scrub-shrub habitat has been reduced from 1 117 to 476 hectares (2,761 to 1,176 acres). This is a reduction of 43 percent with much of this habitat loss between the levees. The amount of palustrine forest has remained fairly constant during this period [2 152 and 2 192 hectares (5,318 and 5,418 acres)]. However, the quality of this type of habitat has decreased. In 1956, 721 hectares (1,781 acres) classified as mature cottonwoods (33.6 percent of the total cottonwood area). In 1986 there were 1 299 hectares (3,128 acres) (57.7percent). The increase in mature cottonwood area indicates a lack of cottonwood regeneration, so replacement cottonwood trees are not being established. These figures indicate that cottonwood communities have not expanded in 30 years. Behind the levees there has been a 49 percent increase of cottonwood-spruce habitat [312 to 464 hectares (770 to 1,147 acres)]. There has also been an increase of sage-grassland habitat into former floodplain locations.

This reflects a conversion of riparian habitat to upland plant community types. This change is attributed to the lack of periodic flooding behind the levees coupled with the conversion of riparian habitat to pastures. The above information is derived from the U.S. Fish and Wildlife Service's Biological Opinion, dated 10 July 1990, issued on the Snake River Levee Maintenance Project. The increase in mature cottonwoods will provide a short-term increase in potential bald eagle nesting and perching trees. However, the reduced regeneration of cottonwoods forecasts future problems. The lack of cottonwood regeneration and the reduction in scrub-shrub habitat indicates that moose habitat quality and quantity is declining.

4. HOW WILDLIFE HABITAT WILL BE IMPROVED BY THE PROPOSED RESTORATION PROJECT.

The proposed restoration tools will improve the wildlife habitat at the four study sites. These structures will help habitat by protecting some of the existing palustrine forest and scrub-shrub habitat from further erosion, creating areas where the deposition of silt-sized sediments is encouraged to allow additional willow and cottonwood colonization, and creation of resting pools for fish. The success of these improvements will provide guidance for future restoration efforts on this reach of the Snake River.

5. HABITAT MEASUREMENTS CONDUCTED.

Habitat evaluation procedures (HEP) were used to evaluate quantity and quality of the palustrine shrub-scrub and the palustrine forest covertypes occurring within the established boundaries of the four restoration areas. Palustrine scrub-shrub covertype areas can be described as areas dominated by willow trees. Palustrine forest covertype areas can be described as areas dominated by narrow-leaf cottonwood trees. A multi-agency team consisting of personnel from the Jackson Hole Flood Protection Project steering committee, Bureau of Reclamation, Greater Yellowstone Coalition, Trout Unlimited, Wyoming Game and Fish Department, U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, and the U.S. Soil Conservation Service developed criteria for the evaluation (USFWS 1992). Field evaluations were conducted in August 1996.

The two species used in this evaluation were the yellow warbler and the song sparrow. These species were chosen because they represent bird species in the middle of the food chain and are associated with dynamic riparian habitat. A wide range of species depend on these habitats and will benefit from improved habitat conditions. Yellow warblers are found in native palustrine scrub-shrub habitats in the western United States. This habitat consists of willow and cottonwood trees. The optimum habitat is a dense scrub-shrub habitat consisting of trees over 1.5 meters (4 feet) in height. Song sparrows are found in the palustrine forest understory. Species that make up the palustrine forest understory include willows, chokecherry, woods rose, blackberry, and current. The optimum habitat for song sparrow is dense shrubs under 6 meters (20 feet), but greater than 1 meter (3 feet) tall, associated with palustrine forest understory.

6. YELLOW WARBLER HABITAT EVALUATION.

The palustrine scrub-shrub covertype areas were evaluated with a modification of the yellow warbler HEP model. This model is designed to evaluate the quality and quantity of palustrine scrub-shrub habitats. The model modifications consisted of establishing variable ranges that could be determined by ocular estimates. Use of this modification allowed initial evaluations to be completed with property access and time constraints imposed on the evaluation. Variables within the HEP models produce a suitability index (SI) value. The SI values are used in an established mathematical equation to determine the habitat suitability index (HSI). The SI and HSI are values between 0.0 and 1.0, with 0.0 indicating no habitat quality and 1.0 indicating optimum habitat quality. The HSI value determined by the equation is multiplied by the area occupied by the covertype to produce the Habitat Units (HU's) the area provides. The HU's are a measure of the quality and quantity of a covertype. The HEP models use one or more variables to determine the quality of the habitat being measured. Three variables were used to evaluate the quality of the palustrine scrub-shrub covertypes:

First, the percentage of shrubs that are hydrophytic (willow) was determined. The assigned values were:

$\leq$ 10% hydrophytic shrubs, SI = 0.1
> 10% and < 75% hydrophytic shrubs, SI = 0.5
> 75% hydrophytic shrubs, SI = 0.9

Second, the mean heights (in meters) of the deciduous canopy cover were determined. The assigned values were:

$\leq$ 0.5 meters mean canopy cover height, SI = 0.1
> 0.5 and < 1.5 meters mean canopy cover height, SI = 0.5
$\geq$ 1.5 meters mean canopy cover height, SI = 0.9

Third, the percent of the deciduous canopy cover was determined. The assigned values were:

$\leq$ 10% deciduous canopy cover, SI = 0.1
> 10% and < 50% deciduous canopy cover, SI = 0.5
$\geq$ 50% deciduous canopy cover, SI = 0.9

7. SONG SPARROW HABITAT EVALUATION.

A modification of the song sparrow HEP model was used. The song sparrow HEP model is designed to evaluate the quality and quantity of palustrine forest understory habitat. Two variables were used to evaluate the quality of the understory of the palustrine forest covertypes:

First the percentage canopy cover of the understory woody growth ≤ 6 meters was determined. The assigned values were:

≤ 10% canopy cover, SI = 0.1
> 10% and < 25% canopy cover, SI = 0.5
≥ 25% canopy cover, SI = 0.9

Second, the mean height (in meters) of the woody understory plants was determined. The assigned values were:

≤ 0.5 meters mean height, SI = 0.1
> 0.5 and < 1.0 meters mean height, SI = 0.5
≥ 1.0 meters mean height, SI = 0.9

U.S. Fish and Wildlife Service and USACE biologists conducted the field evaluations. They delineated the areas of palustrine scrub-shrub and palustrine forest covertypes within each restoration area. Each map was digitized into a Geographic Information System to determine the area of each polygon. These data were used to determine the HU's of yellow warbler and song sparrow habitat within the palustrine scrub-shrub and palustrine forest covertypes. The areas of palustrine scrub-shrub and palustrine forest habitat were mapped from 1956, 1991, and 1996 aerial photography. The HSI value for yellow warbler in 1956 was estimated to be 0.8. The HSI for song sparrow in 1956 was estimated to be 0.85. In 1991, HSI's for both species were prorated by estimating the rate of growth between 1991 and 1996.

A third evaluation was an estimated count of cottonwood trees at each site. The trees were counted in four size groupings to better determine regeneration conditions of the evaluated cottonwood stands. The size groupings used were:

< 10 feet tall
≥ 10 and < 20 feet tall
≥ 20 and < 40 feet tall
≥ 40 feet tall

Data from this evaluation can be used for future comparisons.

8. PROJECTIONS.

Habitat projections were calculated by measuring areas protected by the proposed alternatives at each site over various timeframes. Figure 8 summarizes palustrine scrub-shrub conditions and projections for all four study areas combined. Figure 9 summarizes palustrine forest conditions and projections. The estimated loss in 50 years with no action was calculated using the HSI value for each species and applying it to the estimated area lost between 1991 and 1996, multiplied by 10. The estimated benefit with the project was calculated by assuming the 1956 HSI value will be reached after 50 years. The intermediate HSI values were estimated by prorating the HSI values from the present to 50 years in the future. The area of growth was estimated by measuring the areas around the structures using a Geographic Information System and prorating the growth of each vegetation community around the new structures over the next 50 years.

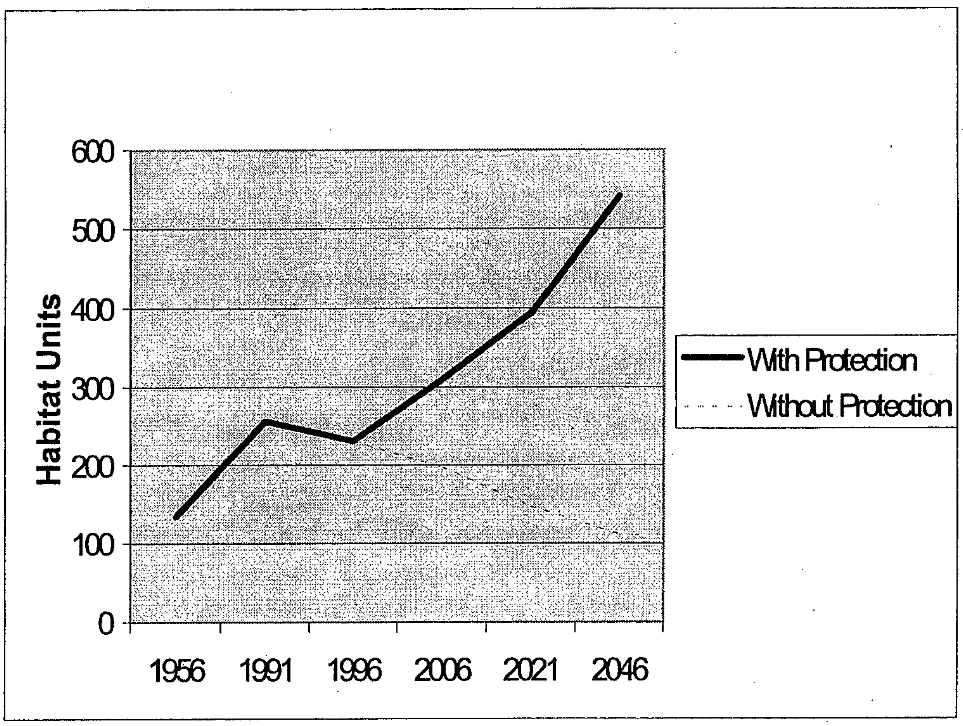

Figure 8. Summary of Palustrine Scrub-Shrub Vegetation Projections

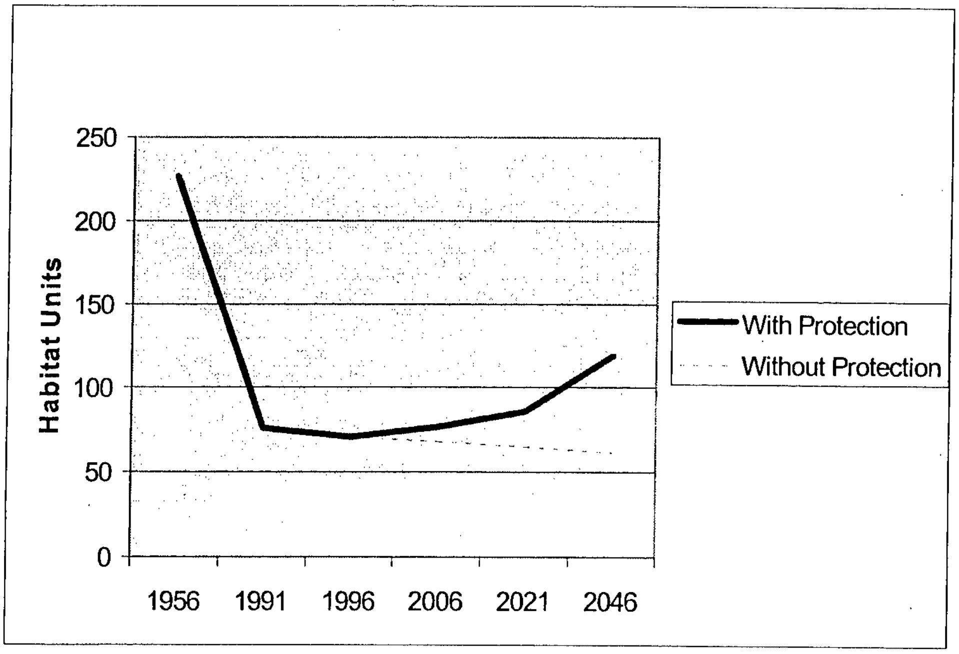

Figure 9. Summary of Palustrine Forest Vegetation Projections

9. WILDLIFE.

The Jackson Hole area is known for its diverse wildlife in the valley and surrounding mountains. The following paragraphs describe the dominant wildlife groups associated with the environmental restoration project areas. The WYNDD has tracked 25 species that occur in the vicinity of Jackson; 22 may use habitats near the environmental restoration project areas (table 3, USACE 1994). Five of these species are Federally listed as threatened or endangered and are discussed later. Most of the remainder are considered extremely rare (less than 5 occurrences) to rare (21 to 100 occurrences) in Wyoming and are discussed in the following paragraphs. Construction activity needed to conduct environmental restoration work would involve noise from heavy equipment and human presence. The degree of disturbance from these activities on wildlife will depend on timing and location.

The only habitat loss expected from the environmental restoration project is that associated with construction activities and will be short-term. These temporary losses will only affect the few wildlife species that use the relatively disturbed habitats currently associated with the levees and access roads.

Wildlife in the construction area would be disturbed by the environmental restoration work. Wildlife respond to disturbance either by avoidance or habituation. Short-term disturbance (such as that associated with the environmental restoration work) will probably cause temporary avoidance that may disrupt foraging/migration patterns or traditional use for a single season, but will have no long-term effects. However, long-term disturbance might cause wildlife to avoid otherwise suitable habitat,

effectively resulting in additional habitat loss. Species that cannot avoid disturbance, such as small mammals, may become habituated.

Since construction will occur during the day, mammals that are mobile and diurnal or nocturnal will be relatively unaffected by the associated disturbance. Some species may temporarily relocate bedding areas.

See table 4 for the Priority I, II, and III Wyoming Species as of 1997 (Deibert, P. pers. comm.). The lists are prioritized for the species of concern and the habitats that these species use. Habitats include stream class (Class 1 is a blue-ribbon trout stream) and big game critical range/parturition areas.

These species and ranges are valued from irreplaceable to high value within the WGFD. These species are not listed on the Federal list, but are mentioned because of their local importance.

Table 2. Partial list of Plant Species Identified by the WYNDD that may Occur Near the Environmental Restoration Project Areas.[1/]

Common Name	Scientific Name	Federal Status[2/]	WY List & Rank[3/]	Habitat[4/]
Oak fern	*Gymnocarpium dryopteris*		2, S1	Moist banks of creeks; moist woods; and wetland/seep areas in spruce/subalpine fir forests on talus.
Steer's head	*Dicentra uniflora*		2, S2	Forest clearings; open slopes with sparse vegetation; rocky soils; sagebrush communities; and disturbed sites.
Boreal draba	*Draba borealis*	USFS	1, S1	Moist soils along streams and on shaded north-facing slopes; calcareous substrate/talus.
Marsh cinquefoil	*Potentilla palustris*		S2	Wetlands; moist places.
Railhead milkvetch	*Astragalus terminalis*		2, S1	Sagebrush grasslands on westerly slopes; river bottoms.
Nuttall townsend-daisy	*Townsendii nutalli*		3, S3	Sandy open areas.
Southern naiad	*Najas guadalupensis*		S1	Warm ponds.
Nodding fescue	*Festuca subulata*		S2	Wet thickets; moist to dry woods; meadows.
Frie's pondweed	*Potamogeton friesii*		S1	Shallow water.
Blunt-leaf pondweed	*Potamogeton obtusifolius*		2, S1	2 to 4 feet of water over soft, mucky bottoms.
Buxbaum's sedge	*Carex buxbaumii*		2, S2	Along shorelines; wet meadows next to lakes.
Fernald alkali grass	*Puccinella fernaldii*		2, S1	Willow thickets, usually in water.
Pale duckweed	*Lemna valdiviana*		2, S1	Warm ponds.
Giant helleborne	*Epipactis gigantea*	USFS	1, S1	Moist meadows in vicinity of calcareous ponds; streambanks; lake margins; and near springs.
Broad-leaved twayblade	*Listera convallariodes*	USFS	2, S1	Grassy areas under aspen-alder.

[1/] Species from the WYNDD were excluded from the list if they are generally restricted to habitat types (*i.e.*, alpine talus and wet limestone cliffs) that do not occur near work areas.

[2/] Federal Status: C2 - Category 2 candidate for Federal listing as threatened or endangered. Current data are insufficient to support listing. USFS - Species is considered sensitive by the USFS.

[3/] State List: List 1 (Highest Priority) - Includes the following: (1) Federally listed and proposed threatened and endangered species and category 1 and 2 candidates for listing (except where current data indicate such status is inappropriate); (2) species designated sensitive on Federal lands or that are being recommended for sensitive designation by the WYNDD; and (3) other species that are quite rare and/or threatened globally or regionally but that have no formal protection status. List 2 (Medium Priority) - Includes the following: (1) species on designated Watch Lists for Federal lands or that are being recommended for Watch Lists by WYNDD, and (2) other species that are moderately rare and/or somewhat threatened globally or regionally. List 3 (Lowest Priority) - Includes the following: (1) species previously considered high or medium priority, but downranked as new information became available, or (2) species that are rare in Wyoming, but common and secure in adjacent areas.
State Rank: S1 - critically imperiled in the state because of extreme rarity or vulnerability to extirpation (5 or fewer occurrences); S2 - imperiled in the state because of rarity or vulnerability to extinction (6 to 20 occurrences); S3 - rare or uncommon in the state (21 to 100 occurrences).

[4/] Habitat: As described in the WYNDD and Hitchcock and Cronquist 1981.

Table 3. Partial List of Wildlife Species Identified by the WYNDD that may Occur Near Environmental Restoration Project Areas.[1]

Common Name	Scientific Name	Federal Status[2]	WY List & Rank[3]	Mgmt. Status[4]	Habitat[5]
Boreal western toad	*Bufo boreas boreas*	C2	S2		Wide variety of habitats-streams, woodlands, meadows.
Spotted frog	*Rana pretiosa*	C2	S3	S-USFS	Near permanent water.
Northern leopard frog	*Rana popiens*		S3S4		Wide variety of habitats.
Common loon	*Gavia immer*		S2BS4N	I-WGFD S-USFS	Lakes.
Trumpeter swan	*Cygnus buccinator*	C2	S1S2BS2N	I-WGFD S-USFS	Lakes, rivers.
Harlequin duck	*Histrionicus histrionicus*	C2	S2BS2N	S-USFS	Swift streams.
Osprey	*Pandion haliaetus*		S3S4BS4N		Along rivers/streams/lakes.
Bald eagle	*Haliaeetus leucocephalus*	LE	S1BS2N		Primarily along rivers and other waterbodies.
Northern goshawk	*Accipiter gentilis*	C2	S4BSZN		Conifer forests; hunts in open areas.
Merlin	*Falco columbarius*		S2S3BSZN	II-WGFD	Open forests and a variety of habitats.
Peregrine falcon	*Falco peregrinus anatum*	LE	S1BS1N		Open wetlands near cliffs.
Whooping crane	*Grus americana*	LE	SHBS1N		Freshwater marshes.
Long-billed curlew	*Numenius americanus*	3C	S3BS4N	III-WGFD	Wet and dry grasslands.
Flammulated owl	*Otis flammeolus*		S1BSZN	S-USFS	Woodlands.
Great gray owl	*Strix nebulosa*		S2B2N	S-USFS	Dense conifer forest; hunts in open wet areas.
Silver-haired bat	*Lasionysteris noctivagans*		S3		Dense conifer forest; hunts in open areas.
Hoary bat	*Lasiurus cinerus*		S3	III-WGFD	Dense conifer forest; hunts in wet open areas.
Long-eared myotis	*Myotis evotis*		S5		Dense conifer/mixed forests; hunts in forests and near water, wetlands.
Gray wolf	*Canis lupus*	LE	SH		Wide variety of habitats.
Grizzly bear	*Ursus arctos*	LT	S1S2		Wide ranging-almost all habitat types.
River otter	*Lutra canadensis*		S3	III-WGFD	Rivers and streams.
American bison	*Bison bison*		S4		Grasslands, open areas.

[1] Species from the WYNDD were excluded from the list if they are generally restricted to habitat types (*i.e.,* alpine talus and wet limestone cliffs) that do not occur in the vicinity of a potential quarry or access/crossing sites.

[2] Federal Status: LE - listed endangered; LT - listed threatened; C2 - Category 2 candidate for Federal listing as threatened or endangered. Current data insufficient to support listing; and 3C - once considered for listing as endangered or threatened but no longer receive such consideration.

[3] State Rank: S1 - critically imperiled in the state because of extreme rarity or vulnerability to extirpation (5 or fewer occurrences); S2 - imperiled in the state because of rarity or vulnerability to extinction (6 to 20 occurrences); S3 - rare or uncommon in the state (21 to 100 occurrences); S4 - apparently secure in the state (many occurrences); S5 - demonstrably secure in the state. For migratory birds, each of these categories is assigned to breeding status (B) and migratory status (N); SZN - species are not of significant concern when migrating through Wyoming; and SHB - historical breeder. State ranks may fall between 2 categories (*i.e.*, S1S2B).

[4] Management Status: I-WGFD (Priority I) - includes federally listed endangered and threatened wildlife as well as species in need of immediate attention and active management to ensure that extirpation or a significant decline in population does not occur; II WGFD (Priority II) - species that are in need of additional study to determine whether intensive management is warranted; III WGFD (Priority III) - species whose needs should be accommodated in resource management planning but do not need intensive management; S-USFS - species is listed as sensitive by the USFS in Region 4 (includes the Bridger-Teton National Forest).

[5] Habitat: As described in the WYNDD; Stebbins 1985; National Geographic Society 1987; Brown 1985.

Table 4. Priority I, II, and III Wyoming Species as of 1997.

Priority I Species Wyoming (which could occur in study area):
American white pelican (*Pelicanus erythrorhynchos*)
Trumpeter swan (*Cygnus buccinator)*
Black crowned night heron (*Nycticorax nycticorax*)
Common loon (*Gavia immer)*
White-faced ibis (*Plegadis chihi*)
Snowy egret (*Egretta thula*)
Caspian tern (*Sterna caspia*)
Forster's tern (*Sterna forsteri*)

Priority II Species Wyoming (which could occur in study area):
Clark's grebe (*Aechmophorus clarkii*)
Western grebe (*Aechmophorus occidentalis*)
American bittern (*Botaurus lentiginosus*)
Merlin (*Falco columbarius)*
Upland sandpiper (*Bartramia longicauda*)
Black tern (*Chidonias niger*)
Burrowing owl (*Athene cunicularia*)

Priority III Species Wyoming (which could occur in study area):
Long-billed curlew (*Numenius americanus)*
Great blue heron (*Ardea herodias*)
Ferruginous hawk (*Buteo regalis*)
Black-backed woodpecker (*Picoides arctus*)
Masked (Preble's) shrew (*Sorex cinereus*)
Merriam's shrew (*Sorex merriami*)
Hoary bat (*Lasiurus cinerus)*
Wolverine (*Gulo gulo*)
River otter (*Lutra canadensis)*
Lynx (*Felis lynx*)

Other species not listed above:
Loggerhead shrike (*Lanius ludovicianus*)
Goshawk (*Accipiter gentilis)*
Spotted frog *(Rana pretiosa)*
Harlequin duck (*Histrionicus histrionicus)*

Other species not listed above (Continued):
Elk (*Cervus elaphus nelson*)
Moose (*Alces alces shirasi*)
Mule deer (*Odocoileus hemionus hemionus*)
Bighorn sheep (*Ovis canadensis canadensis*)

10. MAMMALS.

Elk (*Cervus elaphus nelson*), mule deer (*Odocoileus hemionus hemionus*), Shiras moose (*Alces alces shirasi*), bighorn sheep (*Ovis canadensis canadensis*), and American bison (*Bison bison*) are the most prominent wildlife in the Jackson Hole, Wyoming area. Aquatic furbearers, black bear (*Ursus americanus cinnamomum*), coyote (*Canis latrans*), and a variety of small and medium-sized mammals also occur.

11. BIG GAME.

Big game concerns focus on usage patterns within the region of Jackson Hole, Wyoming. Important winter feeding areas are located near the work area and migration patterns to and from these feeding areas go through the Snake River drainage. The usage patterns include spring-summer-fall range, winter range, winter/year-long range, critical winter range, and critical winter/year-long range (USACE 1990). The local mule deer, elk, moose, and bighorn sheep herds represent these types of usage. The critical range areas are the areas of greatest concern. Most conflicts should be avoided with the time restrictions imposed by river flows. If heavy excavations (gravel removal and sorting) are performed early in the work window and work takes place during daylight hours, conflicts will be minimized even further. The WGFD recommends work cease by November 15. Depending on the year, there may be opportunities to extend the work window into December or beyond if WGFD biologists are consulted and conditions warrant an extension.

The Jackson Hole area has one of the largest populations of elk in North America. Jackson Hole and the surrounding mountains provide about 259 000 hectares (640,000 acres) of summer range for approximately 15,000 elk. During the winter, the populations concentrate in much smaller areas. The National Elk Refuge, just northeast of Jackson, provides about 9 710 hectares (24,000 acres) of winter habitat for 10,000 elk. The refuge includes winter range and a supplemental feeding area for elk (USACE 1994). The WGFD classifies this refuge as a crucial winter range, which is defined as one that determines whether the elk population in the area reproduces and maintains itself at or above WGFD target levels. In addition to the refuge, there are several other smaller wintering areas used by elk in the upper Snake River drainage (USACE 1994).

The Jackson Hole area provides habitat for mule deer throughout the year. Mule deer use the area primarily for migration. The Sublette herd winters in the Green River

Basin to the east. A small herd of mule deer winter in the South Park Elk Feed Grounds area (USACE 1990).

The upper Snake River drainage provides year-round habitat for about 200 to 300 moose. During the winter, an additional 400 to 500 moose from the surrounding uplands migrate into the river bottom (USACE 1994). Winter densities range from 6.9 moose per kilometer (4.3 per mile) between the South Park and Wilson Bridges to 9.7 moose per km (6 per mile) between Wilson Bridge and the confluence of the Gros Ventre River (USACE 1994).

Bighorn sheep are present seasonally in all major drainages within the Snake and Gros Ventre River Basins (USACE 1994). The Gros Ventre drainage contains the primary wintering area for bighorn sheep that summer in the Gros Ventre Wilderness. In addition, a major wintering area occurs at Camp Davis, approximately 6.4 km (4 miles) southeast of the confluence of the Hoback River. Sheep use steep slopes and breaks along the Snake and Hoback Rivers year-round. Within these high elevations drainage brush and grassland areas are the primary feeding areas for bighorn sheep (USACE 1994). The following are big game usage within the specific environmental restoration project areas.

12. <u>OTHER MAMMALS</u>.

Shrews (*Sorex* spp.) and voles (*Microtus* spp.) are common in riparian areas along the Snake River and its tributaries and are expected to inhabit the environmental restoration project areas. Aquatic furbearers such as beaver (*Castor canadensis*), mink (*Mustella frenata*), and muskrat (*Ondatra zibethicus*) are commonly seen in streams, ponds, and backwater areas along the Snake River near Jackson. The levees are generally too rocky or exposed to provide habitat for either the beaver or muskrat. Beaver frequently construct dams in the Jackson Hole area (USACE 1994).

There are four mammal species (excluding Federally listed or candidate species) occurring in the Jackson Hole area that are tracked by the WYNDD table 3. The river otter (*Lutra canadensis*), a species considered rare in Wyoming, has been documented by the WYNDD. This species has been observed along the Snake River near logjams, pools, and oxbows that concentrate fish (USACE 1994). The hoary bat (*Lacers cinerus*), also considered rare in Wyoming, has been reported in the Jackson Hole area. Two other rare species, including the silver-haired bat (*Lasionycteris noctivagans*) and long-eared myotis (*Myotis evotis*), have been documented by the WYNDD in the Jackson Hole area. Wolverine (*Gulo gulo*) and lynx (*Felis lynx*) are also rare and occur in the region.

Small and medium-sized mammals would be affected by disturbances associated with construction at environmental restoration project areas. Many of these species will avoid areas subject to disturbance; others may habituate. A river otter would likely temporarily avoid the environmental restoration project areas during construction, but would not experience any long-term effects from disturbance.

13. BIRDS.

The upper Snake River drainage provides habitat for a wide variety of resident and migratory birds, including waterfowl, raptors, and passerines. Approximately 150 different species have been observed, and 119 are documented or expected to breed in the area (USACE 1994).

The USACE will schedule construction activities, in areas that have critical waterfowl brood-rearing habitat, after nesting season to avoid impacts to nesting waterfowl and other birds. Construction at these sites will be scheduled after 1 August, or the 15 if bald eagle constraints apply. Resident birds and migrants (including several species considered rare in Wyoming) are expected to temporarily avoid foraging or staging in areas subject to disturbance. No impacts to wintering birds, including the trumpeter swan, are expected because construction activities for restoration will not occur at this time.

14. WATERFOWL AND WATER BIRDS.

The wetlands, ponds, backwater, and tributary creeks in the Snake River floodplain provide habitat for waterfowl and waterbird spring/fall staging, breeding, nesting, brood rearing, and wintering. The most prominent include Canada geese (*Branta canadensis*), trumpeter swans (*Cygnus buccinator*), and sandhill cranes (*Grus canadensis*); but common mergansers (*Mergus merganser*), mallards (*Anas platyrhynchos*), buffleheads (*Bucephala albeola*), and Barrow's goldeneyes (*B. islandica*) are also common seasonally. Frequently observed waterbirds include the American white pelican (*Pelecanus erythrorhynchos*), great blue heron (*Ardea herodias*), black-crowned night heron (*Nycticorax nycticorax*), western grebe (*Aechmophorus occidentalis*), and cormorant (*Phalacrocorax auritus*). Rarer migrants include American bittern (*Botaurus lentiginosus*), black tern (*Chidonias niger*), Caspian tern (*Sterna caspia*) and Forster's tern (*Sterna forsteri*), white-faced ibis (*Plegadis chihi*), Clark's grebe (*Aechmophorus clarkii*), and snowy egret (*Egretta thula*). Long-billed curlew (*Numenius americanus*) and upland sandpiper (*Bartramia longicauda*) are associated with the upland shrub-steppe habitat. They may be found along the river corridor foraging during migration.

Of the species listed above, only two have a high potential for nesting/living in the work area: the black-crowned night heron and great blue heron. The ibis and snowy egret may be seen in wetland areas outside of the levee system during migration. Western and Clark's grebes are associated with the lakes and ponds in the region. The other species listed could live in the forest/woodlands adjacent to the river or migrate through the riverine system. Because work will be restricted to outside of the nesting season and removal of existing trees and shrubs will be avoided wherever possible, impacts to these species should be minimal or nonexistent.

On average (1982 through 1987), approximately 1,320 dabbling and 666 diving ducks winter on the river between Moose Junction and South Park (USACE 1994).

Between Wilson and South Park Bridges, winter duck densities frequently average 224 per km (139 per mile) of river and tributary. This area is considered crucial winter waterfowl habitat (USACE 1994). Much of this same area is also considered crucial brood-rearing habitat (USACE 1994).

The harlequin duck (*Histrionicus histrionicus*), a candidate for Federal listing as threatened or endangered, is a species considered very rare in Wyoming and has been documented by the WYNDD in the Jackson Hole area (table 6-4). The common loon (*Gavin immer*), also rare in Wyoming and intensively managed, has been reported in the Jackson Hole area.

About 42 breeding pairs of Canada geese use the Snake River between the confluence of the Gros Ventre River and South Park Bridge. These consist of 22 pairs north of the Wilson Bridge and 20 pairs to the south (USACE 1994). The most important goose nesting areas include the confluence of the Gros Ventre River, the confluence of Blue Crane Creek, and between the confluence of the Spring Fork of Fish Creek and the confluence of Spring Fork of Spring Creek (USACE 1994). Stable islands with trees and logs that provide the cover necessary to reduce nesting losses from avian predation characterize these areas (USACE 1994). Areas 1, 4, and 10 are located near these nesting sites.

Brood-rearing habitat for Canada geese along the Snake River includes grazed meadows, ponds, gravel pits, and islands. The most important brood-rearing habitat is found in the following locations: (1) in wet meadows on the National Elk Refuge; (2) along the east side of the Snake River from the confluence of the Gros Ventre River to the Wilson Bridge; (3) the Snake River between Wilson and South Park Bridges; (4) the area between Fish Creek and the Snake River south of the landing strip; (5) South Park; and (6) about 3.2 km (2 miles) of Flat Creek upstream from its confluence (USACE 1994). All environmental restoration project areas are within Canada goose brood-rearing habitat.

Between 1982 and 1988, the upper Snake River supported an average of 390 wintering Canada geese (USACE 1994). Wintering habitat is often limited by the lack of ice-free water. Crucial winter habitat includes: (1) nearly all of the river between the Wilson and South Park Bridges; (2) about half of the South Park area; (3) the area between Fish Creek and the Snake River south of the landing strip; and (4) about 3.2 km (2 miles) of Flat Creek upstream from its confluence (USACE 1994). Other wintering areas include the river upstream of Wilson Bridge and two small off-river areas north of the bridge (USACE 1994). All of the environmental restoration project sites are within crucial Canada goose winter habitat.

The trumpeter swan is a candidate for Federal listing as threatened or endangered and is considered extremely rare in Wyoming. This species is intensively managed by the WGFD and is designated as sensitive by the USFS in the Jackson Hole area (table 3). In 1988, a total of 98 trumpeter swans wintered in the Jackson Valley, Grand Teton National Park, and the National Elk Refuge (USACE 1994). Trumpeter swan

winter habitat in Wyoming, Idaho, and Montana appears to have the following characteristics (USACE 1994):

- soft substrate less than 5.1 cm (2 inches) deep;
- water less than 1.2 m (4 feet) deep;
- channel greater than 15.2 m (50 feet) wide;
- banks with no trees or shrubs;
- loafing sites with water less than 10.2 cm (4 inches) deep or sand/gravel bars in or near feeding areas;
- no physical barriers that bisect feeding or loafing areas or travel corridors;
- shallow water containing beds of diverse aquatic macrophytes that are available for at least 75 percent of the winter and not iced over for more than 2 or 3 days at a time; and
- water velocity in feeding areas that does not exceed 45.7 cm/s (1.5 feet per second).

The Snake River, from the start of the Right Bank Federal Levee to just south of the Wilson Bridge, is considered potential wintering habitat for the trumpeter swan (USACE 1994). The river in this area is less than optimal for wintering swans because of the lack of calm water and absence of aquatic vegetation. The following areas provide crucial winter habitat for trumpeter swans: (1) The Snake River downstream of the Wilson Bridge; (2) about half of the South Park area; (3) the area between Fish Creek and the Snake River south of the landing strip; and (4) about 1.6 km (1 mile) of Flat Creek upstream from its confluence (USACE 1994). The Fish Creek, South Park area, and lower Flat Creek wintering areas received about 5,951 swan use days per year between 1982 and 1986 and 7 to 14 breeding pairs rely on these areas annually (USACE 1994). Fish Creek is the most heavily used of these areas and Flat Creek the least. Environmental restoration project Areas 1 and 4 south of Wilson Bridge are within crucial winter habitat for the trumpeter swan (USACE 1994).

There are several nesting pairs of trumpeter swans in the Jackson Hole area and there are at least three specific areas that are important for brood rearing (USACE 1994). None of the environmental restoration project areas are near trumpeter swan nests or brood-rearing locations.

Sandhill cranes nest in the upper Snake River drainage, primarily in beaver ponds and seasonally flooded emergent wetlands. This area supports between four and eight pairs of nesting cranes annually, but none are near the environmental restoration project areas (USACE 1994).

During spring migration, about 30 to 100 sandhill cranes use the meadows between South Park area and Spring Creek (USACE 1994). Area 1 is the only work site near this staging area.

The proposed work has the potential to impact some of these species. The timing of the work should minimize these impacts since breeding season will be coming to

an end. Care will be needed to avoid impacting water birds, especially at Areas 1 and 4. Most of the birds would avoid the construction zones.

15. RAPTORS.

The upper Snake River and associated habitats support high numbers of fish and small mammals that provide prey for a variety of raptors. The most commonly observed raptors are the osprey (*Pandion haliaetus*), red-tailed hawk (*Buteo jamaicensis*), Swainson's hawk (B. *swainsonii*), and American kestrel (*Falco sparverius*). Other raptors known to occur in this area include ferruginous hawks (*Buteo regalis*), golden eagles (*Aquila chrysaetos*), western screech owls (*Otis kennicotii*), great horned owls (*Bubo virginianus*), and short-eared owls (*Asio flammeus*) (USACE 1994). Rarer hawks include the goshawk (*Accipiter gentilis*) and merlin (*Falco columbarius*). Most of these raptors nest in trees behind the levees.

Annually, three to four pairs of osprey nest along the Snake River in the Jackson Hole area, usually in partially or completely dead standing trees or artificial structures (USACE 1994). Approximately seven osprey nest sites have been documented along the Snake River between the beginning of the Left Bank Federal Levee and South Park Bridge (USACE 1994). All of the environmental restoration project areas are in the vicinity of these osprey nest sites. The osprey is considered rare or uncommon in Wyoming (table 3).

Two owl species tracked by the WYNDD (excluding Federally listed or candidate species) occur in the Jackson Hole area (table 3; Corps 1994). The flammulated owl (*Otis fammeolus*), considered extremely rare, and great gray owl (*Strix nebulosa*), considered very rare in Wyoming, have been seen in the vicinity of the Snake River downstream of the environmental restoration project areas.

Burrowing owls (*Athene cunicularia*) are found in Wyoming. They migrate to the state primarily for breeding. They are associated primarily with prairiedog towns but will nest in the burrows of other mammals. It is highly unlikely that burrowing owls use the Jackson Hole area because of the lack of prairiedog towns and the short warm season. This type of habitat is not found in the Snake River corridor so the environmental restoration work would not affect this species.

Raptors would avoid construction activities until they habituate to it. Removal of existing vegetation should be avoided wherever possible. Bald eagles are discussed later.

16. OTHER BIRDS.

Other birds known to commonly occur in the Snake River floodplain near the Jackson Hole area include the loggerhead shrike (*Lanius ludovicianus*), black-backed woodpecker (*Picoides arctus*), killdeer (*Charadrius vociferus*), tree swallow (*Tachycineta bicolor*), yellow-headed blackbird (*Xanthocephalus xanthocephalus*),

common nighthawk (*Chordeiles minor*), belted kingfisher (*Ceryle alcyon*), and Wilson's warbler (*Wilsonia pusilla*) (USACE 1994). These species and others are expected to occur in the vicinity of the environmental restoration project areas. These species will face the same impacts as water birds and raptors.

17. REPTILES AND AMPHIBIANS.

Relatively little is known about amphibians and reptiles in the Jackson Hole area. Two frog species, the spotted frog (*Rana pretiosa*), and northern leopard frog (*Rana pipiens*); and one toad species, the boreal western toad (*Bufo bufo boreas*), considered very rare or rare in Wyoming, have been documented in the vicinity of the environmental restoration project areas (table 3). The sagebrush lizard (*Sceloporus graciosus*) and western terrestrial garter snake (*Thamnophis elegans*) are probably two of the most common reptiles in the area. The existing riparian vegetation within or near the environmental restoration work could have these species present. These species may be impacted if present within the side channels when construction activities are taking place. Most reptiles and amphibians will move from the area. The timing of the work in late summer and fall will reduce impacts.

18. THREATENED AND ENDANGERED SPECIES.

The USFWS has documented five species in the Jackson Hole area that are classified as threatened or endangered. Endangered species observed in this area include the bald eagle (*Haliaeetus leucocephalus*), whooping crane (*Grus americana*), and peregrine falcon (*Falco peregrinus*). The Jackson Hole area is also within historical range for the grizzly bear (*Ursus arctos horribilis*), a threatened species, and gray wolf (*Canis lupus*), an endangered species (USACE 1994).

a. Bald Eagle.

The upper Snake River drainage provides year-round habitat for bald eagles. Nesting usually occurs between 1 February and 15 August. The Snake River population unit, which includes the Snake River in Wyoming, its tributaries, and Jackson Lake, consisted of 24 known breeding pairs in 1982 (USACE 1994). In 1992, seven active bald eagle nest sites existed between Moose and South Park Bridge, including one just downstream of Moose, one near the confluence of the Gros Ventre River, and five between the Wilson and South Park Bridges (USACE 1994). Between 1982 and 1989 the productivity of bald eagles nesting between Moose and the South Park Bridge averaged 1.47 young per nesting attempt, a number considered excellent (USACE 1994).

Bald eagles in the Jackson Hole area feed primarily on fish in the summer and waterfowl and carrion in the winter. Between 5 and 15 bald eagles were observed during the winter along the Snake River between Moose and the South Park Bridge prior to 1994 (USACE 1994). This entire reach has been designated by WGFD as

crucial wintering and nesting habitat (USACE 1994). All of the environmental restoration project areas are contained within this habitat.

In the past, a bald eagle nest has been mapped toward the north end of the trees on the east side of the channel in Area 1. No active nests were located in this area during 1998.

Bald eagles nested near Area 4 in 1998. Two active nests were located on the east side of the river. One nest was located about 4 to 5 km (2.5 to 3 miles) south of the Wilson Bridge, 45 m (50 yards) outside the levee. The second nest was about 2.4 km (1.5 miles) south of the first nest, 274 to 365 m (300 to 400 yards) outside of the levee. Both nests were on private property.

Bald eagles nested near Area 9 in 1998. The nest was located on the west side of the river, outside of the levee, near human habitation.

Bald eagles nested near Area 10 in 1998. The nest was located in a grove of trees on the north side of the Gros Ventre River near the mouth. Both eagles were spotted during a tour of the area in 1998.

The CAR received from the USFWS (appendix B) stated, "No work activity within 1 mile (1.6 km) of any active nests would occur between February 1 and August 15." For this reason, work will only be allowed within 1 mile (1.6 km) of active nests (current year) between August 16 and January 31. Changes to this work window must have prior approval from the USFWS. No other constraints have been applied to nesting bald eagles. Since it is still unknown when work will actually commence, the environmental restoration project area will be surveyed for bald eagle nest in the spring of the year when work is to be performed.

Because of the equipment access restrictions due to river flows, construction and excavation activities should not conflict with nesting. All standing mature trees in the work area will be avoided if at all possible. Trees that are leaning or already on the ground may be moved aside to facilitate excavation and construction. All of the known eagle nesting trees are currently located outside of the levee system. The biologist on site will work with the construction crew to avoid areas where equipment could damage mature trees. Bald eagles may also winter in the area. The biologist on site will monitor for the presence of eagles and direct the work crews to avoid activities that might disturb the eagles. It is not anticipated that the work activity will cause additional disturbance to the eagles using the area beyond the human disturbance already occurring through normal recreational use.

Bald eagles are likely to be found in or near the work area most of the year. The chances of the environmental restoration project having any impact on the bald eagle are minimal due to the timing of the active work. There should be no direct impacts (mortality, loss of nest, *etc.*) or long-term population impacts (reduced

reproduction, *etc.*). There may be some minor displacement of foraging or roosting eagles.

b. Peregrine Falcon.

Until recently, the peregrine falcon was considered extirpated from Wyoming (USACE 1994). A recovery program was started in 1980. Between 1980 and 1987, 153 peregrine falcons were released to hack sites (the term used for reintroduction sites) in Wyoming, primarily in Yellowstone National Park and in or near the National Elk Refuge. In 1986 and 1987, 50 peregrine falcons were released to 5 hack sites in Wyoming. One of these hack sites is located northwest of Wilson and another is on the National Elk Refuge. Approximately 80 to 83 percent of the released birds reached independence (USACE 1994).

The wetlands and streams along the Snake River south of Wilson Bridge support a variety of birds that are prey for peregrine falcons. This area is considered forage habitat for peregrine falcons and three to four adults and sub-adults have been observed in this region between 1982 and 1988 (USACE 1994).

In 1988, 6 nesting pairs of peregrine falcons in Wyoming produced 10 young (USACE 1994). In 1998, two eyries (nest sites) were located in the vicinity of the Grand Teton Mountains. Currently, one peregrine falcon forages in the South Park area near Fish Creek. This area is near the West side of Area 4.

Peregrine falcons are expected to leave the area soon after nesting is complete. The timing of nesting is similar to that of the bald eagle. They could be in the area any time between February and August. The biologist on site will monitor for the presence of peregrine falcons and provide guidance to the contractor to avoid activities that might disturb the peregrine falcons. Since the bulk of the environmental restoration work will occur after nesting season, the chance of the environmental restoration project impacting the foraging of peregrine falcons should be minimal.

c. Whooping Crane.

The whooping crane is one of the rarest birds in North America. Reintroduction efforts at Gray's Lake National Wildlife Refuge in Idaho have resulted in whooping cranes occupying habitat in western Wyoming since 1977. In 1985, about 26 to 31 whooping cranes in the Gray's Lake population spent the summer in Wyoming. In 1988, only 16 of the Gray's Lake flock were still alive. Whooping cranes are occasionally sighted in the Jackson Hole area, primarily along the Gros Ventre River (USACE 1994).

Whooping cranes do migrate through the area of Jackson Lake during early spring. There is a chance a whooping crane may stop along the river in the Jackson Hole area, especially if sandhill cranes are using the area. The chance of a whooping crane stopping in the work area is extremely rare. The whooping cranes are attracted

to wetland pastures and not the riverine corridor between the levees. The confluences of Blue Crane and Fish Creeks are the only two areas that might attract cranes. Areas 1 and 4 are within this region of the river. Most of the work will be taking place between August 15 and November 15. For these reasons, the environmental restoration project should have little or no impacts on the whooping crane population.

If a whooping crane is seen during work activities, work will cease, and WGFD and USFWS personnel will be contacted. Work would resume only after USFWS personnel have been consulted on how to proceed.

d. Grizzly Bear.

The historical range of the grizzly bear once included most of Western North America. Currently, only six areas in the United States, including Yellowstone and Grand Teton National Parks, support self-sustaining grizzly bear populations (USACE 1994).

The grizzly bear is a resident species to the area, primarily north of the Jackson Hole area. Current management in Wyoming by WGFD is to discourage grizzly bears from living in areas of human habitation. The last sighting of grizzly bears in the Jackson Hole area was in 1994. An adult female with three cubs was captured near Area 4 and relocated to an area north of Jackson Hole. The female was attracted to the area because 15 cows, which were killed by lightning, were buried near the site.

The chances a bear will be seen on site is very rare, but precautions are needed since late summer/fall is the time of highest bear activity as they search for food in preparation for hibernation. Workers will be directed not to leave food and other garbage on site that may attract bears to the area. Some of these stipulations could include keeping the work site free of food and garbage and storing trash and food in approved containers. If a grizzly bear is seen during work activities, WGFD and USFWS personnel will be contacted. Since there is only a slight chance of encounters between grizzly bears and humans, the proposed work is unlikely to have an impact on the grizzly bear population.

e. Gray Wolf.

The gray wolf historically inhabited all habitats in the Northern Hemisphere except tropical rain forests and deserts (USACE 1994). Currently, the largest populations of wolves in the lower 48 states occur in northern Minnesota. Remnant populations are believed to exist in Wyoming, Washington, Idaho, Montana, Michigan, and Wisconsin (USACE 1994). In the summer of 1992, a wolf was sighted in Yellowstone National Park, the first documented observation in over 20 years. Wolves have been sighted this year following the elk herds into the Jackson Hole area (WGFD 1998, USFWS 1998). Until this year, there had been no sightings of wolves near Jackson, Wyoming. Wolves following the elk are unlikely to go near the town of Jackson. They will likely stay in the hills surrounding the elk refuge. Wolves generally

avoid human activities. Like the grizzly, an effort should be made to avoid attracting wolves to human habitation. The same guidelines associated with grizzly bear management should be applied to gray wolves. This includes keeping the site clean of food debris and other garbage. If dead animals are found on or near the work site, they should be removed and disposed of properly. If a gray wolf is seen during work activities, WGFD and USFWS personnel would be contacted.

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